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The Fellows Who Know

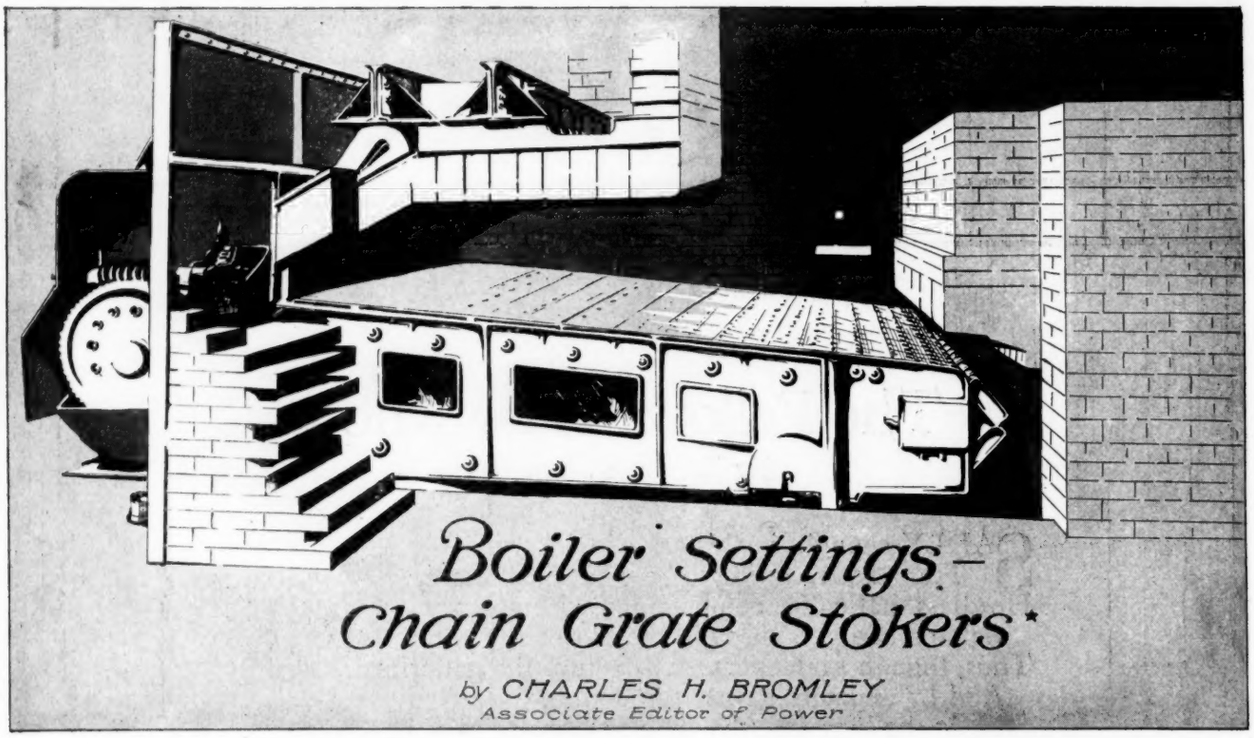
By RUFUS T. STROHM

SADLY enough, in this era of trickery,
Humans are trying to be what they're not,
Heedless that coffee compounded with chicory
Seldom can pass through the test of the pot.
Thus, though pretenders may capture the galleries
And by audacity garner the dough,
Still, in the long run, the choicest of salaries
Drop in the jeans of the fellows who know.

SOME of the ignorant, wantonly venturing,
Knowing they're either dead right or dead wrong,
Blind to the danger and deaf to the censuring,
Trust to their bluffing to help them along;
Thus, while they're constantly fearful and quavering,
Wondering whether they'll stay or they'll go,
No such alarms or suspicions of wavering
Trouble the lives of the fellows who know.

BLUFF and deception may win temporarily,
Leaving Old Honesty far in the rear,
Still, prudent folks will consider them warily,
Choosing instead to be strictly sincere.
No reputations of worth and solidity
Out of imposture and knavery grow,
Yet recognition with pleasing rapidity
Comes to the doors of the fellows who know.

GUESSWORK is weakness—a sand rope whose rottenness
Millions of toilers still stupidly try,
Though it betrays into lasting forgottenness
Those who so foolishly on it rely.
Knowledge is power, and men of sagacity,
Yearning for honors the world can bestow,
Ceaselessly striving for increased capacity,
Share the rewards of the fellows who know.



Boiler Settings—Chain Grate Stokers*

by CHARLES H. BROMLEY
Associate Editor of Power

One of several articles on boiler settings for various boilers and types of stokers most suitable for the different coals. The chief purpose of the articles is to assist those in the Middle West and Northwest who are confronted with combustion problems by reason of the zone system for the distribution of bituminous coal enforced by the Fuel Administration. Several excellent chain-grate settings are shown in this article.

ONE does not have to argue the adaptability of the chain-grate stoker for the coals of the Middle West and Northwest, or, as they are sometimes called, Eastern Interior coals. They have demonstrated it. The writer does not, however, indorse the statement that this type alone is *most* suitable for these coals. This claim defied refutation until recently because the underfeed stoker had not shown what it could do with them. The chain grate is admirably suited to these coals where the load conditions do not impose boiler ratings of more than 250 per cent. of builders' rating.

The chain grate, like all other stokers, frequently suffers because of poorly adapted boiler settings. Sometimes these are unavoidable; that is, in places where sufficient headroom is not available for raising the boilers, where conditions prohibit lowering the stoker or floor line, or because the purchaser is obstinate or wants "something nearly as good for less money." The builder, therefore, cannot always put in his ideal setting.

The seriousness of this is felt, especially during times like these when coals of considerably poorer grades than those for which the setting is at all adapted find their way into the plant. High settings with correct arches originally installed, avoid troubles due to using coals of widely varying volatile content, and where high combustion rates are necessary or may become so.

Some excellent chain-grate settings are shown herewith. Notice that no secondary arch is used with this particular stoker, the arch being very long. Fig. 1 shows a Stirling boiler, and what strikes the observer as unusual is the absence of a secondary arch, simplifying construction, though not appreciably increasing maintenance charges.

Where secondary arches are provided, they do not always exert any appreciable effect, at least upon the incoming coal, owing to the curtain wall between the two arches. The arch in Fig. 1 is effective over the whole fuel bed. This is important where smokelessness and high combustion rates are needed, because with a chain-grate stoker the resistance to the fuel bed is comparatively small and the thickness, density and porosity of the fuel bed do not conduce to such thorough mixture of air and gases *in the fuel bed* as with an underfeed fire, high combustion rates considered. The arch is, of course, ventilated.

The height of a Stirling boiler setting is taken as the distance from the center of the bottom drum to the floor line. The setting, Fig. 1, would be improved for Middle Western coals if this was 6 ft. instead of 5 ft., as shown. Have in mind that this applies to the chain grate; for the underfeed stoker it should be at least 1½ ft. higher. For lignite combustion would be improved if the setting were not less than 8 ft. The author bases this opinion upon recent performances of underfeed stokers burning lignite.

Broadly, it may be said that the tubes of a Stirling boiler should always be exposed to the direct heat of the furnace gases and fuel bed. In fact, it is the writer's opinion that tubes immediately above the fire should never be covered with C tile or with any other material

*For previous articles see the following issues "Power": "Zone System for the Distribution of Bituminous Coal," May 14; Coals of the United States," May 21; "Boiler Settings," May 28.

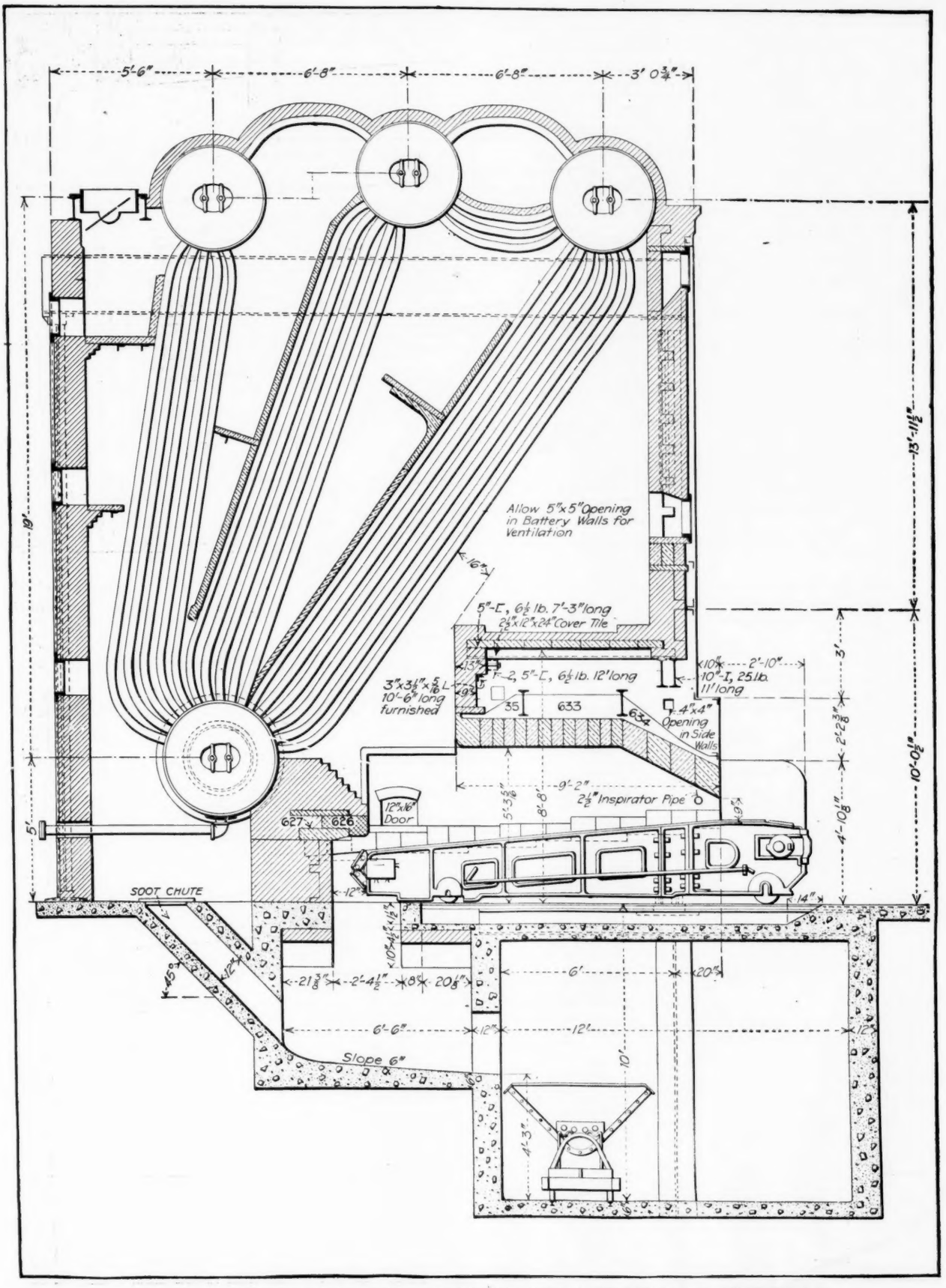
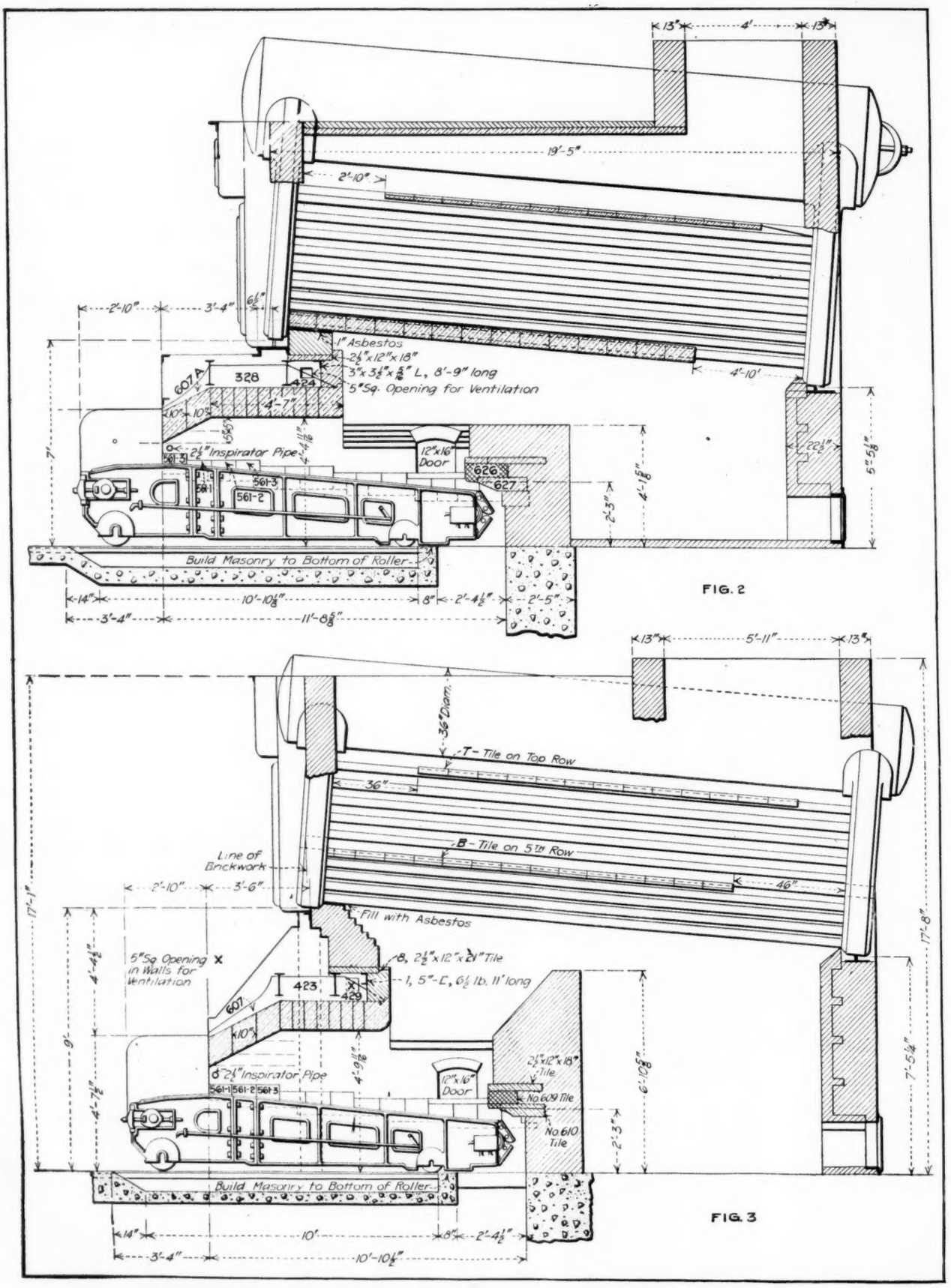


FIG. 1. EXCELLENT CHAIN-GRATE STOKER SETTING FOR BOILERS OF STIRLING TYPE
The setting would be improved if the distance between center of mud drum and floor was 6 ft. instead of 5 ft. Notice that no secondary arch is used.



FIGS. 2 AND 3. CHAIN-GRATE STOKER SETTINGS, BOILERS HORIZONTALLY BAFFLED

Fig. 2—The objection is that the setting is too low and that the baffle is on the lowest row of tubes. Fig. 3—A good setting; notice baffle is on the fifth row of tubes

that completely covers them, shutting out the radiant heat of the fire. This applies to any boiler. Some tubes should be exposed to the direct heat; this avoids excessive tube failures and better distributes the evaporation per square foot of tube surface of the boiler.

The setting shown in Fig. 1 is installed in a famous soap manufactory in Kansas City, Kan. Notice that no water-back is used; bauxite tile, furnished by the stoker builder, is provided. The number referring to the bricks denotes the trade designation.

Fig. 3 shows an excellent setting for water-tube boilers of the type illustrated. The boiler is 9 ft. above the floor, insuring large combustion volume. Combustion would be improved if it were 10 ft., and for lignite, 12 ft. The arch is the same as in Fig. 1. The bottom tile is on the fifth row of tubes. This seems a little high; but it is probable that there will soon be a universal abandonment of tile on the very bottom row. It is the writer's belief that the boiler manufacturers would welcome this change. Fig. 2 shows a setting for a horizontal baffle boiler with the tile on the bottom row of tubes.

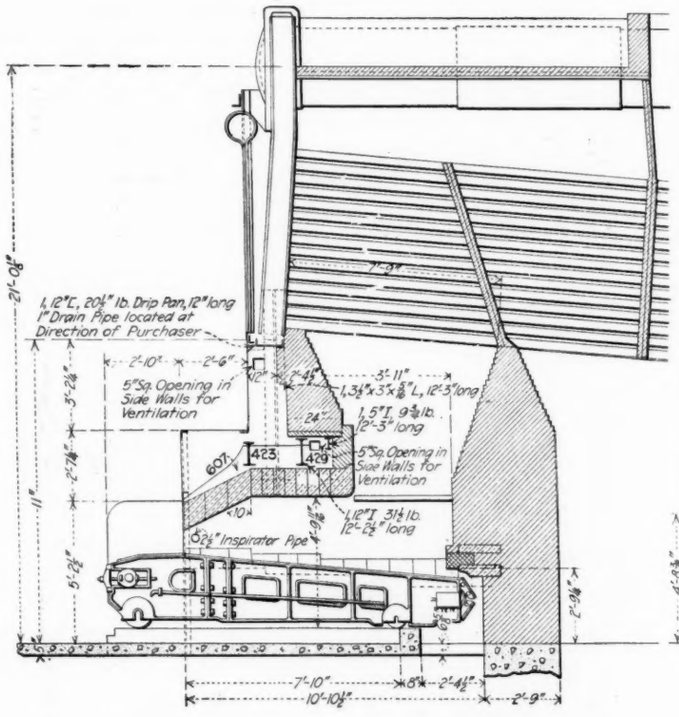


FIG. 4. AN 11-FT. SETTING FOR HIGH-VOLATILE COAL

The setting in Fig. 4, for a vertical baffled boiler, is good practice. The boiler is set high, being 11 ft. above the floor, and the arch and bridge-wall insure a fairly good mixture of air and combustible gases.

The baffling is designed to give an approximately uniform gas velocity throughout the entire flame travel. The setting is adapted for any Middle Western coal. Notice that the flame plunges directly among the tubes from the incandescent zone. The high setting permits of this, but only a high setting permits of i'

Fig. 5 shows a good setting for an Erie City boiler or any boiler of this general type. All the important dimensions are given.

Where lignite or slack high in moisture is to be burned on a chain grate, the reflecting arch is to be recommended. Some excellent settings using these arches, the function of which is to throw the flame forward so that the heat may assist in evaporating the moisture from the coal as the latter comes onto the grate, were shown in *Power* for Apr. 2, 1918, p. 472, and Apr. 30, 1918, p. 611.

The Standardization Committee of the Smoke Prevention Associations recently recommended the following:

Water-tube boilers are constructed of tubes having 1 in. pitch to the foot, 1½ in. pitch to the foot and 3¼ in. pitch

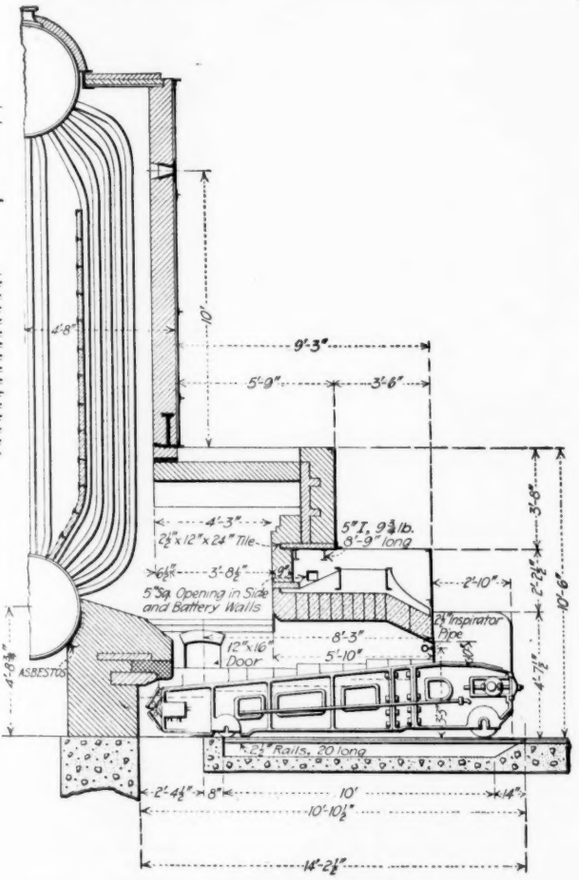


FIG. 5. FOR ERIE CITY AND SIMILAR BOILERS

to the foot. Chain grates are of two kinds, the horizontal and the inclined grate, and the height of the boiler setting is determined from the vertical line immediately back of the front boiler header to the water-back of the stoker. This distance we propose as being five feet, and means that the water-back is located five feet back of the inner side of the front header. Three feet in front of the water-back a line is drawn that measures seven feet from the under side of the lower tube [row of tubes?] to the top of the grate. This standardizes all chain-grate stokers on all horizontal water-tube boilers, and is applicable to all settings requiring only 50 per cent. overload. [50 per cent. more than builders' rating?] If larger overloads, such as 200 or 250 per cent. rating, are required, this line should be extended about three feet.

The dimensions given will be found satisfactory for the coals of the Middle West, but it is probable that for lignite the settings should be 2 ft. higher. Experience indicates that lignite needs extraordinarily high setting.

If the moisture is 15 per cent. or more, a reflecting

arch, after the fashion of Fig. 6, will be found a valuable aid to combustion, as such an arch sweeps the flame forward, evaporating the moisture in the coking region, thus avoiding serious loss of temperature at the surface of the fuel bed. In Fig. 6 *A* shows the arch applied to a step-grate stoker, *B* to a chain-grate stoker.

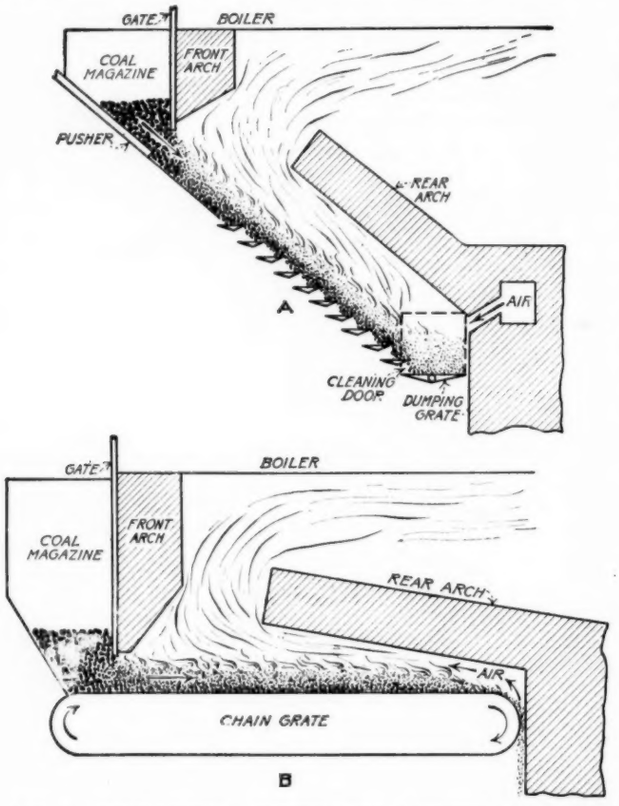


FIG. 6. REFLECTING ARCHES FOR LIGNITE AND HIGH MOISTURE COALS SUGGESTED BY KREISINGER OF THE BUREAU OF MINES; A, STEP-GRATE; B, CHAIN GRATE

Fig. 7 shows a setting recently developed by the American Radiator Co. for burning lignite in heating boilers. Notice there are no grates, that the coal feeds down when a shovelful or two of ash is removed. The writer does not have any performance data on this setting, but it may suggest something to those interested in furnace design for lignite under power boilers. The distribution of air is interesting.

Condenser Was Full of Ammonia

By T. T. GROVER

After having operated without trouble for two years, a small packing-house refrigerating plant showed excessive head pressure. The trouble started in the early spring while the condensing water, which was taken from a river, was something like 38 deg. It was evident that if the pressure was more than normally high at this time, it would practically render the plant inoperative in summer when the water temperature went up to 80 to 85 degrees.

The plant had been superficially overhauled during the winter, and the condenser coils, which were of the atmospheric type, had been scraped and the scale removed. The only reasonable conclusion was that considerable air had been drawn into the system during the overhauling and the operators forthwith proceeded to purge the condenser.

A considerable portion of the ammonia charge had disappeared; the condenser pressure remained nearly as high as before and gradually got higher as the water temperature increased.

The heavy summer load was coming on, and the operators were at their wits end as to what to do about it. Finally it was concluded that the only remedy was to increase the condenser capacity by adding more stands to the ten already in service. Before deciding on this point, however, the chief called in the writer to investigate the problem and if necessary add more weight to the request for a larger condenser when it was put up to the management.

After purging the condenser once more and testing the pressure gages and doing everything else that I could think of, the head pressure still remained much too high. After roughly estimating the amount of gas handled by the condenser, I found that it was doing only about two-thirds of its normal capacity, based on the manufacturer's rating and from my experience.

I went over the condenser a second time, putting my hand on each stand to see if all the coils were working—something I had neglected to do the first time. To my surprise one-half of them were at the temperature of the condensing water. This pointed to the coils being

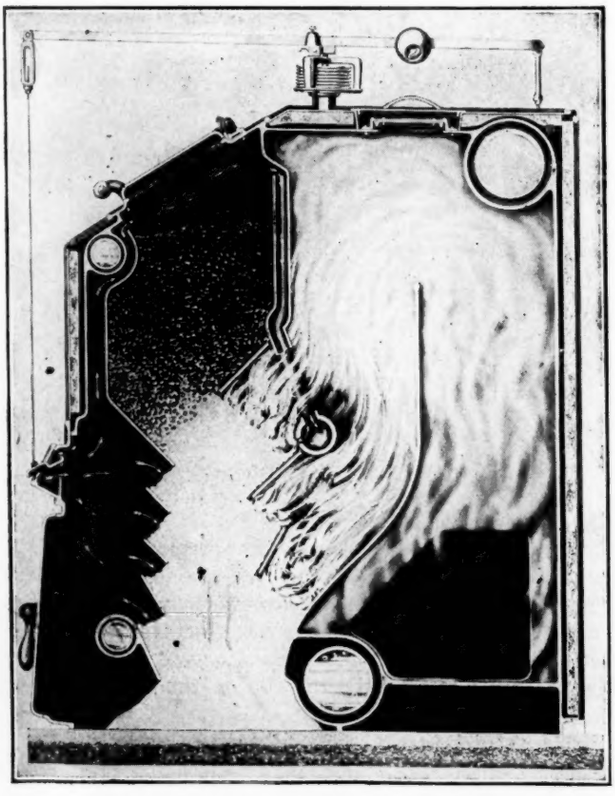


FIG. 7. FURNACE FOR BURNING LIGNITE IN HEATING BOILERS; NO GRATES ARE USED

airbound, and I at once got busy and purged them again.

To my surprise there was practically no sign of air; after it had been blowing for a few seconds, there was the unmistakable crackling of the water in the barrel that I was purging the coils into, that is always an in-

dication that mainly all ammonia is coming from the coil that is purged. It had no effect on the condenser pressure. Evidently, it was not air or foul gases in the condenser that was causing the trouble. Furthermore, if there was no air in the coils, it was a foregone conclusion that they were full to the top with liquid, as otherwise the dead coils would have been of the same temperature as the others.

The only logical explanation was that the outlet from the coils to the liquid line was blocked in some way, and this assumption was not unreasonable after I investigated the connections at the bottom where each coil connected to the liquid line. The coils of the condenser were made up of 2-in. pipe, and at the bottom, where they connected to the liquid line, this had been reduced to ½-in. by means of a reducing elbow. Evidently, scale or other foreign matter had accumulated in the coil and collected at the reduced point in sufficient quantities to entirely block the passage.

The remedy was quite simple. I shut off all the dead coils at both ends and pumped them out until the pressure was down to atmosphere. The rest of the system was pumped down so that when the dead coils finally were pumped down to near atmospheric pressure, there was about 225 lb. pressure on the coils that were working. Leaving the pump-out connection to the dead coils open and the valve on the discharge end of the coils shut, I quickly opened the valve in the connection between the coil and liquid line for a few moments. This put a pressure of about 225 lb. on the blocked section and in the reverse direction of the normal flow, and it cleared it immediately as was evidenced by the coil frosting at once and the suction pressure "taking a jump."

When the plant was settled down to normal operation again, the head pressure was down to 125 lb. as against 175 lb. Also, there was an abundant supply of ammonia. With the coils blocked, the liquid had accumulated in the coils every time they had been purged until they probably were full up to the top at the time the trouble was discovered. At first, when there was considerable air in the condenser, this accumulated in the dead coils and prevented a large accumulation of liquid, but as this was gradually blown out, the coils slowly filled up, and this explained the gradual disappearance of the ammonia.

Power Loss in Waterwheel Pit

By David R. Shearer

Scattered throughout the country there are numerous small water-power developments representing practically every type or design of waterwheel, operating under various conditions. Some of these installations are equipped with all the refinements of engineering practice, while others are nothing more than crude makeshifts.

Considered from the standpoint of efficiency in power production about 90 per cent. of these plants show one serious fault—a fault not easily corrected in existing installations, though easily obviated at the time of installation. This is "water reaction" in the wheelpit under the turbine, which may decrease the hydraulic efficiency to a marked extent. In many cases the trouble is caused by not allowing a sufficient depth of dead water directly under the draft tube of the wheel, or it may be caused by the inadequate size of the wheelpit or tailrace.

To secure the maximum efficiency from a waterwheel, it is necessary that the flow of water from the draft tube and through the tailrace should be slow and quiet, somewhat as shown in Fig 1. The water level in the wheelpit should also be at practically the same point of elevation as the tail water of the stream into which it discharges. A loss of even a few inches head in the

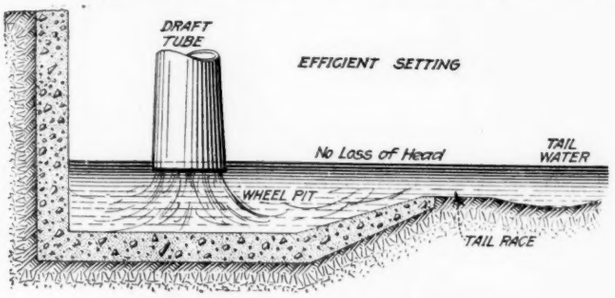


FIG. 1. CORRECT DESIGN FOR TAILRACE

tailrace may seriously affect the power of a low-head development. Frequently, the utmost care is used to conserve all the available head above the wheel and then a serious loss is allowed to occur in the tailrace or wheelpit.

Some months ago a small hydro-electric plant was tested to determine what had caused a marked decrease in the available power. The head was eleven feet and the wheel was supposed to develop about 150 hp., but at the time of the test the maximum output was only about 100 horsepower.

After some investigation it was found that a recent flood had partly filled the wheel pit with gravel and had so choked the tailrace that eighteen inches of the original head was lost. In this case the remedy was easy, for it was only necessary to clean out the gravel to the bedrock in order to secure normal power. However, in many small plants the original excavation has not been carried to a proper depth, as in Fig. 2, and the water is choked at the end of the draft tube and boils forth like a small geyser, dissipating in this watery

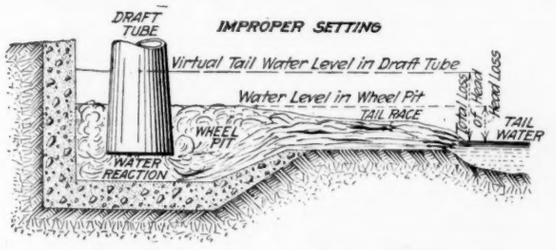
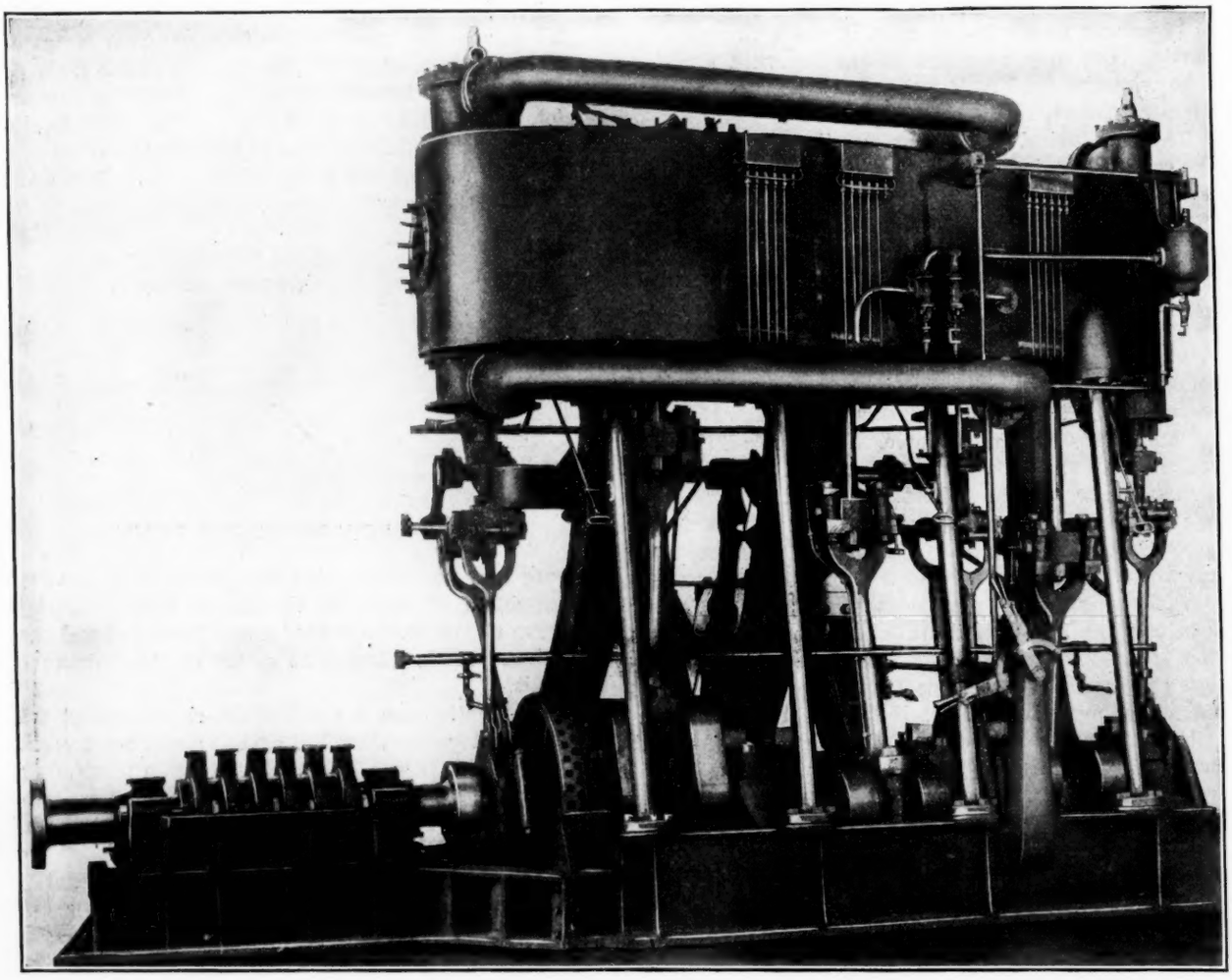


FIG. 2. TAILRACE TOO SHALLOW AND SMALL

ebullition much of the energy which should be given to the wheel and turned to practical purposes.

At this particular time, when all the water power is urgently needed to save coal, it is of vital importance that efficiency investigations be made for the purpose of determining how to increase power production and that corrections be applied where possible. Some slight changes in the wheelpit or tailrace at little expense may add considerably to the output of the plant.

Emergency Fleet Engines



THE attack of German submarines on the shipping of the allied and neutral countries has resulted in the sinking of a large number of cargo steamers, the lost tonnage of which must be made good. Because of these losses and the advisability of getting the greatest efficient movement from the available tonnage, the United States Shipping Board has complete charge of all the merchant ships afloat flying the American flag.

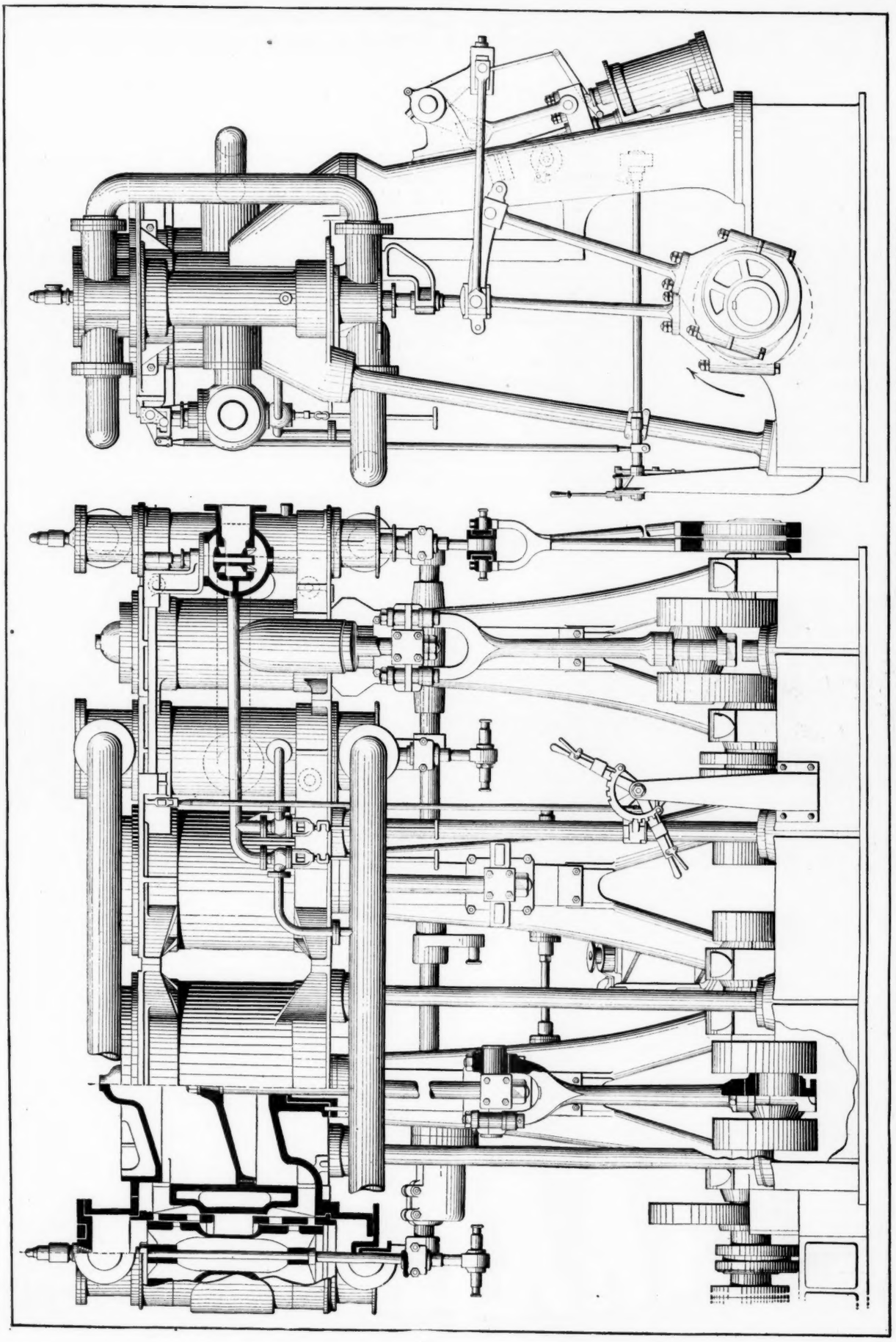
The American Fleet Corporation is a subsidiary of the United States Shipping Board, and its duty is to build ships. As a result of the Shipping Board activities, it has the supervision of the output of more than 150 shipyards throughout the United States, which are all engaged in the greatest shipbuilding program that any nation has ever undertaken. Some of the ships laid down in these yards are completed, others are nearing completion, and the next few months will bring about the launching of a large number of merchant ships that will be engaged in carrying supplies for our own and our allied soldiers. As a matter of fact, under direction of the Shipping Board there have already been launched something like 236 steel and wooden vessels, with aggregate tonnage of 1,440,627. There are now operating 157 shipyards with 753 ways in use, with a predicted launching of four ships per day.

Engineers are interested in the general type of engine that is to be used in these ships that are being built. One of the fore and aft triple-expansion engines, built by the Buckeye Engine Co., Salem, illustrated herewith, shows the general arrangement, the line cut showing a front and end view. It is of 700 hp. capacity and has a 15½-in. diameter high-pressure cylinder, a 26-in. intermediate and a 44-in. low-pressure cylinder. The stroke is 26 in. Piston valves are to be used on all cylinders and are $7\frac{1}{16}$, $14\frac{1}{16}$ and 15 in. in diameter respectively, and are 3 ft. $\frac{15}{16}$ in. long.

The columns on which the cylinders are secured are 7 ft. 1 in. high and are 7 ft. wide at the base. The frame consists of a front and back column, as shown in Fig. 2. This front column is 4½ in. in diameter and the back column is an A-shaped form when looked at from the forward end. These columns carry the guide bars.

As is common practice, the crank rod and eccentric rod are made with the well-known type of boxes. The crankpins are 8½ in. and the wristpins 4½ in. in diameter. The shaft is $8\frac{3}{8}$ in. in diameter. and the cranks are placed at 120 deg. apart.

Two engines, port and starboard, will be the equipment of each ship in most instances in which these engines are placed.



SHOWING THE GENERAL ARRANGEMENT OF THE EMERGENCY FLEET FORE AND AFT TRIPLE-EXPANSION ENGINES

The Electrical Study Course—Characteristic Curves of Compound Generators

The voltage characteristics of compound generators under varying loads, the method of adjusting the series windings to obtain the correct amount of compounding, also the long-shunt and short-shunt connections, are discussed.

WITH a series winding on the polepieces along with a shunt winding, as in the compound generators, Fig. 3, the load-voltage curve will to a certain extent be a combination of the shunt characteristic curve, Fig. 2, and the series curve, Fig. 8, in the previous lesson, issue of May 21. In the compound-connected machine, Fig. 3, current is flowing through the shunt-field winding only, and this is adjusted by the field rheostat to give normal voltage at the armature terminals. When a load is connected to the machine, as in Fig. 4, the current passing through the armature will tend to cause the voltage at the brushes to decrease, but the total-load current flowing through the series winding will increase the strength of the magnetic field and cause a greater voltage to be produced to compensate for the drop in the armature and series-field winding. If we assume that the machine is normally generating 110 volts at no load, the density of the magnetic circuit would correspond to point *A* on the magnetization curve, Fig. 1. When the machine is carrying full load, if the current flowing in the series-field winding increases. the magnetic density to correspond to point *B* on the curve, then the armature will be generating about 124 volts; that is, the voltage generated in the armature has increased from 110 to 124, or 14 volts. Now, if the volts drop in the armature, from no load to full-load, is only 14, then the volts at the armature terminals at full load will be the same as at no load.

At first thought it may seem an easy matter to proportion the series-field winding so that it will just compensate for the drop in the armature circuit. A further consideration of the curve, Fig. 1, will show that this is impossible. If point *A* indicates the no-load voltage and point *B* the volts generated in the armature at full load, point *C*, half-way between *A* and *B*, will indicate the volts at half load. But from *A* to *C* the voltage has increased from 110 to 120, whereas from *B* to *C* it has only increased from 120 to 124, or 4 volts, against 10 on the first half of the load. The volts drop in the armature is proportional to the amperes, consequently if full-load current causes a drop of 14 volts, then half full-load current will cause 7 volts drop. But with half full-load current flowing in the series-field winding, in this case, it caused 10 volts increase, therefore, the voltage at the brushes is 3 volts higher than at no load. What has really happened to the voltage of the compound generator from no load to full load is indicated in curve *B*, Fig. 2, assuming 200 amperes full load. Here it is shown that although the voltage is the same at full load as at no load, nevertheless, it has not been constant between these points, increasing in value during the first half of the load and then decreasing to normal again during the last half. Furthermore, it is not possible to design a compound generator that has a constant voltage from no load to full load. However, conditions similar to that indicated by curve *B*, Fig. 2, can be approximated.

A compound generator that develops the same voltage at full load as at no load is said to be flat-compounded. It is possible, by proportioning the shunt- and series-field winding, to design a compound machine where the voltage will increase from no load to full load, as indicated by curve *A*, Fig. 2. For example, we assume that the full-load current causes 14 volts drop in the armature. Now, if the current flowing through the series-field winding caused a 20-volt increase in the

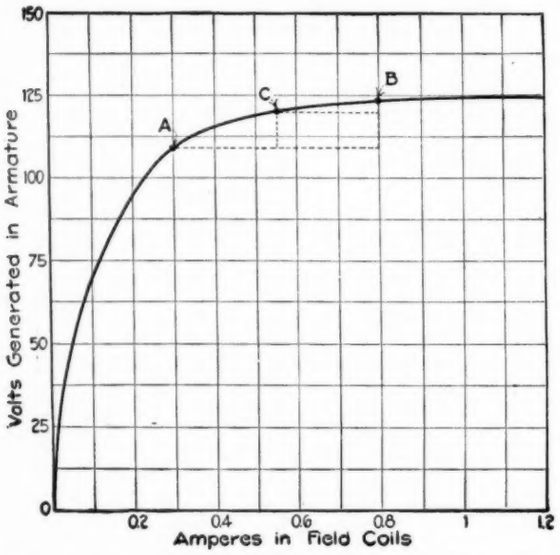


FIG. 1. DIRECT-CURRENT GENERATOR VOLTAGE CURVE

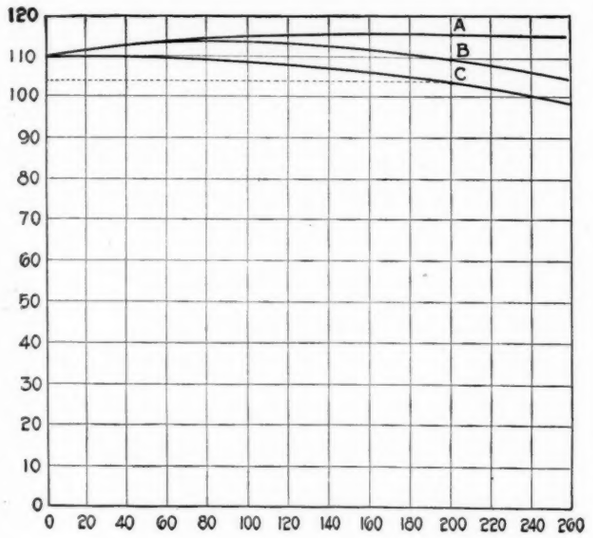


FIG. 2. COMPOUND-GENERATOR LOAD-VOLTAGE CURVE

armature, then the voltage at the armature terminals will be 20 — 14 = 6 volts higher at full load than at no load. When the voltage of a compound generator increases from no load to full load, the machine is said to be over-compounded.

On the other hand, suppose that when full-load current is flowing in the series-field winding it caused only 8 volts increase; then, since there is 14-volts drop in the windings at full load and only eight of these volts are compensated for, the pressure will decrease at the brushes, 14 — 8 = 6 volts. Such a condition is represented by curve *C*, Fig. 2. A compound generator the voltage of which decreases from no load to full load is known as being under-compounded.

Another feature in obtaining the proper amount of compounding of the generator is the proper number of turns in the series winding. This winding in the large-sized machine is made of a heavy copper bar, as in Fig. 5, therefore, the terminals will have to come out on opposite sides, so that the connection can be made conveniently between the coils. This means that the minimum number of turns in the coil must be 1.5. Then, to maintain the proper position of the coil's terminals the number of turns will have to be 1.5, 2.5, 3.5, etc. One-half turn in the series-field winding at first thought may not seem to be of any serious importance. However, when it is considered that in a 200-kw. 110-volt machine the normal full-load current is approximately 2000 amperes, and this current flowing through one-half turn gives 1000 ampere-turns, the effect that only a small fraction of a turn in the series winding will have upon the voltage of such a machine at once becomes apparent.

Here again, in the design of the series winding, it is impossible, except by a coincidence, that the correct number of turns can be obtained. The result is that as the series-field winding is designed on most compound generators, the machine is over-compounded.

For example, assume that in working out the design of a machine it is found to give the proper amount of compounding, that 3.8 turns will be required in the series winding. In this the designer has the choice of using only 3.5 turns and having the machine slightly under-compounded, or using 4.5 turns and over-compounding the machine. The latter is the best course for several reasons. Due to imperfections in the materials and workmanship, the machine may vary somewhat from what was expected of it. In fact, it is practically impossible to build two machines after the same design and from the same lot of stock and have them both possess the same characteristics. Therefore, it is good policy to use a liberal design in the series-field winding, since there is a simple means for adjusting the ampere-turns of this winding when the machine is over-compounded. This consists of connecting what is known as a compounding shunt directly across the series-winding terminals, as shown in Fig. 6.

After the machine is built and in operation in the shop, a test is made to find out the amount of resistance that must be connected across the series-field terminals to give the required compounding, and then a shunt is made for this purpose and connected to the terminals of the series winding. Then, instead of all the load current passing through the series winding, only part of it does, depending upon the resistance of the shunt. If the full-load current of the machine is 1000 amperes and only 800 amperes are required to compensate for the volts drop in the series and armature windings, at full load, then the shunt is made to have a resistance four times as great as that of the series winding, so that when it is connected in parallel with the series winding one part of the current will pass through the shunt and four parts through the series winding, or any degree of over-compounding may be obtained up to the maximum by increasing the resistance of the shunt. Direct-current generators have been built for railway work in which the voltage increased from 500 at no load to 550 at full load, this increase in voltage being

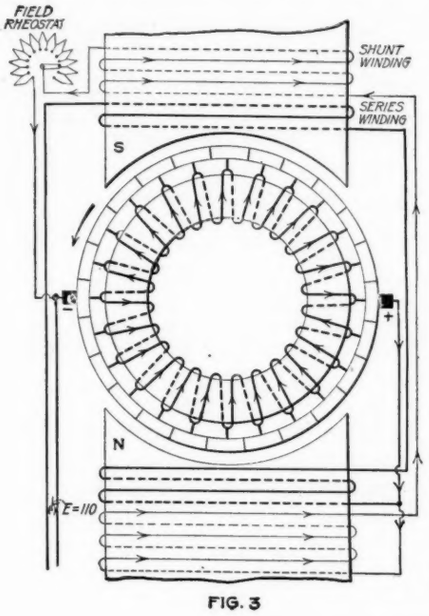


FIG. 3

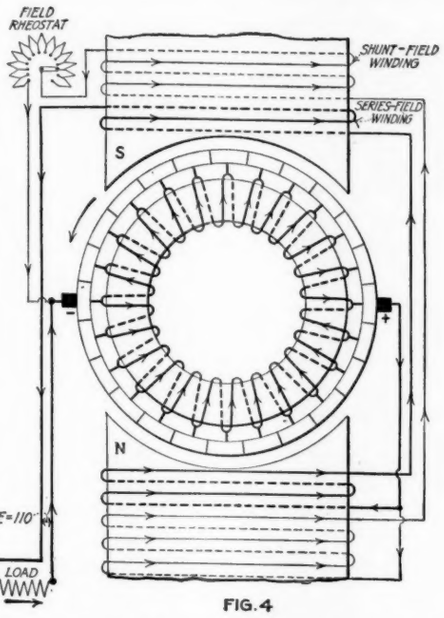


FIG. 4

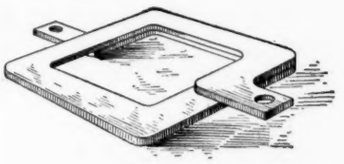


FIG. 5

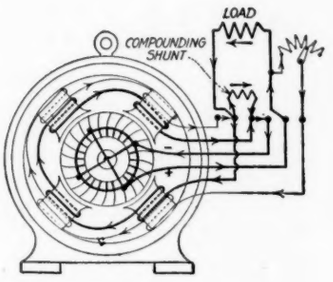


FIG. 6

FIGS. 3 TO 6. COMPOUND-GENERATOR CONNECTIONS AND SERIES-FIELD COIL

Fig. 3—Diagram of Compound Generator. Fig. 4—Diagram of Compound Generator Connected to Load. Fig. 5—Large-Capacity Series-Field Coil. Fig. 6—Compound Generator Showing Location of Compounding Shunt

used to compensate for the volts drop in the feeders.

In passing, attention may be called to the way that the shunt-field windings are connected. In Figs. 3 and 4 the shunt winding is connected directly to the armature terminals. This is known as a short-shunt connection. In Fig. 6 the shunt winding is connected directly across the series winding and armature in

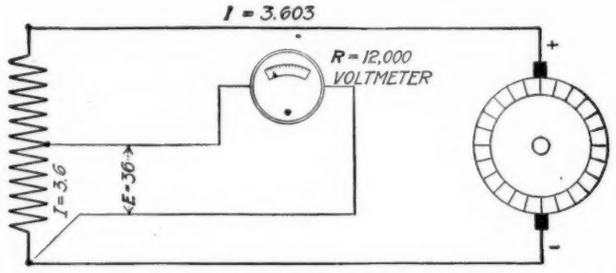


FIG. 7. VOLTMETER CONNECTED ACROSS SECTION OF RESISTANCE

series, so that in this case the shunt-field current passes through the series winding also. This is known as a long-shunt connection. Since the shunt-field current is only a very small percentage of the total load of the machine, it is evident that it makes little difference which connection is used, the choice being more a matter of convenience than anything else.

Fig. 7 gives the layout of the first problem in the last lesson. This problem is solved by Ohm's law. The current flowing through a voltmeter is in all cases equal to the volts impressed across its terminals divided by its resistance, or in this case equals $36 \div 12{,}000 = 0.003$ ampere. The resistance of the section of the circuit that the voltmeter is connected across is equal to the volts drop across the section (the voltmeter reading), divided by the current, or $36 \div 3.6 = 10$ ohms. The total current in the remaining part of the circuit will be that taken by the voltmeter and that flowing in the section the voltmeter connects to, or $0.003 + 3.6 = 3.603$ amperes.

The second problem was, if the resistance of a voltmeter is 15,000 ohms and when connected across a given circuit 0.01 ampere flows through it, does the instrument indicate the correct voltage of the circuit if the needle points to 140 on the scale?

In all cases the correct reading of a voltmeter is equal to the resistance of the instrument times the current passing through it, in this problem, $15{,}000 \times 0.01 = 150$ volts. In this case the instrument reads 140; therefore. it is indicating $150 - 140 = 10$ volts low.

A given compound generator develops 125 volts at no load, the armature and its external connection has 0.075 ohm resistance, the series field winding 0.045 ohm. Neglecting the effect of the load upon the shunt field, what will be the voltage across the armature terminals at a 150-ampere load, also across the line terminals, if the load current of 150 amperes through the series winding causes the armature to generate 20 volts more than at no load?

A Day With the Refrigerating Troubleman

BY E. W. MILLER

The troubleman takes the reader along on two hurry calls for help from plants where the refrigerating machines refuse to properly perform the work.

A REFRIGERATING plant of 15 tons capacity had been installed in a large department store. The equipment for the building was electrically driven, and the heat was supplied from an adjoining building; so the plant was operated by the electricians. After the refrigerating plant was installed, a man was left with the chief electrician for a short while.

A month after the man had left, we received a rush order from the chief electrician to come at once; the crankshaft of the machine had been broken. It was plainly not a case of defective material. I asked the chief electrician what had taken place, and he appeared to be as much in the dark as I about it. He said he was out of the engine room at the time of the accident and when he came in the belt was on the floor and the machine had stopped.

I was unable to find anything wrong, and to keep peace in the family we sent out another crankshaft. This was in the latter part of February. About the middle of April we received another complaint from this plant. I was sent out again, and this time the electrician informed me that he could not maintain the required temperatures in the various rooms.

I first turned my attention to the compressor, with which, of course, I was thoroughly familiar. Judging from the sound of the valves, the load indicated by the wattmeter and the suction and discharge pressures, I was sure that the compressor was not to blame.

The compressor was running very hot; the suction line was bare, and there was not a sign of frost as far back as where the line passed out through the wall to the coolers. The condenser pressure was lower than I would expect for the temperature and speed of the compressor, and the suction pressure was also low for the temperatures carried in the coolers, which were liberally piped.

On entering the cooler room, I found that the coils were only slightly frosted; the sharp frost line that is always present on an expansion valve that is working properly was missing, and the liquid line leading to the valves was warm—considerably warmer than it should be according to the water temperature and the head pressure carried.

Everything pointed to a shortage of ammonia. The problem was to account for its disappearance, as we had provided a liberal charge when the plant was started. The electrician said there had been no blowouts and he had never detected a leak except at the stuffing-box.

The entire system was pumped down to vacuum, after which I cut in the coils one at a time. In this way one could determine just about what proportion of the

ammonia had been lost by seeing how many coils could be operated with the ammonia on hand.

Expansion cocks had been provided instead of valves. When I opened the first one, after pumping down, I was surprised that there was no sound of liquid passing the valve. There was no sign of frost on the valve. Always, after pumping down in this way the expansion valve will frost at once it is opened. This coil was entirely dry and had evidently not been used. Upon inquiry the chief informed me that it had not been in service since the plant had been started. This led to further investigations, and I had a hunch where all the ammonia had gone to. The suction valve was shut.

Coil Full of Liquid

I casually asked the chief if he had ever had this coil in service and if so, for how long. This brought forth the information for which I had been looking: He said that he had cut it in on the day he found the crankshaft broken and had shut it off again and had not used it since.

I had him get one of the men to open the valve slowly after we were back in the engine room. I then partly closed the suction stop valve on the machine and awaited developments. There was a succession of thumps in the machine, and the belt nearly came off and screeched as it slipped on the pulleys. I gave the suction stop valve a spin that sent it shut at once and the racket stopped as suddenly as it had started. The thumps were so severe that it jarred the floor of the engine room and made the pipes connected to the compressor dance in the hangers; two of the joints started to leak.

It was then explained to him that this was what happened when he had opened up this coil at the time the crankshaft had broken; that the coil evidently was full of liquid, that he likely opened the valve quite lively and sent a slug of liquid of large volume into the suction line, the shock twisting off the shaft.

The suction stop valve was then gradually opened until the entire mass had been worked through the compressor. The system was pumped out and the bonnet removed from the expansion cock of the coil that had caused the trouble. Here I found that a piece was broken out large enough so that when the valve was closed as far as it would go, it would not quite shut off the flow to the coil. A new cock was put in and the plant started. It went along splendidly and did the work easily.

Suction Valve Should Have Been Open

The leaking cock had allowed the coil to gradually fill with liquid ammonia. The weather was cold at first, and sufficient ammonia was left in the rest of the system to keep the temperatures down until the weather became warmer. When he had attempted to open the valve and cut in the coil at the time the crankshaft broke, the large amount of liquid had, as stated before, rushed into the suction line and back to the compressor, causing the accident. He had then shut off the valve, and the coil had gradually filled again, removing a large portion of the ammonia from the active part of the system, and when the weather warmed up there was not enough to do the work. If the suction valve had been left open all the time, as it should have been, none of this trouble would have happened and the leaking expansion cock would have been detected in a short time by the inability to close it tightly.

In another case a 25-ton plant had been installed in a hotel. About two months later we received a call to come and "straighten out the plant," as it refused to work. Arriving, I was informed by the engineer that the cooler temperatures were "scooting up," the compressor was ice-cold, the suction pressure was down below atmosphere, and the expansion valves were barely cracked open.

Cooling was done by brine circulated from the engine room. A triple-pipe brine cooler was used, and a centrifugal pump circulated it. At first I could discover nothing wrong. The brine pump was spinning along merrily, and to all appearances everything was working nicely. The temperature of the brine as it left the cooler was much higher than usual, and judging from this in connection with the low suction pressure and the cold machine, it looked as though the cooler was not doing the work.

Thermometers in the inlet and outlet of the cooler showed the temperatures were about the same. Evidently the cooler was out of commission. I opened one of the drain valves at the bottom of one of the coils to see if there was any circulation; nothing came out. I removed one of the return bends and found ice. The rest of the coils were more or less in the same condition.

Thawing Out the Cooler

The machine and pump were shut down and a steam hose used to thaw the ice. Burlap and bags were used to wrap the cooler and hot water from the feed-water heater run over it. This thawed it out rapidly. All the return bends were removed; heated rods driven into the center pipes.

When I thought most of the brine was out, I opened up the valves in the inlet between the cooler and the pump and also the suction valve to the latter, intending to utilize the head on the pump to force out the remainder of the ice in the bottom pipes. To my surprise nothing happened. I ran the rod clean through the pipe, and a little brine trickled out.

Opening the pet-cock on the top of the pump showed there was no pressure on it. But brine flowed freely from a drain valve on the other side of the suction stop valve. Evidently there was something wrong with the suction stop valve to the pump. On removing the bonnet from this, we found that it had dropped the gate; remained closed, and as there then was no circulation through the brine cooler, the brine froze. As soon as the cooler was frozen, there was nothing to boil the ammonia, and it came back to the machine and froze it; the suction pressure, of course, also came down, as there was no ammonia evaporated.

To prevent further recurrence of the trouble, another thermometer was provided for the inlet to the cooler and the temperatures read every half-hour. If this had been done before, the trouble would have been noticed before the cooler froze and an investigation would have located the trouble before any damage had been done.

Stets Boiler-Feed Controller

The function of a controlling element on a boiler feed-water line is to maintain the water level in the boiler at a predetermined height and to do so by maintaining a continuous flow of water to the boilers. Numerous designs of regulators have been devised of both the float and the thermostatic-control type. The more simply a feed-water regulator is constructed the less likely it is to get out of order and the more dependable it will be. It has been difficult to make the float of the float-controlled regulator strong enough to withstand the high steam pressure now carried and at the same time buoyant and powerful enough to operate the controlling valve.

The design of the water-controlling valve is also an important matter, and the proper type of valve seems to have been adopted in the new Stets boiler-feed controller, which is manufactured by the Williams Gauge Co., Pittsburgh, Penn. This controller is self-contained, and the float-control principle is used. It is made of two types, as shown in Figs. 1 and 3.

The controller, Fig. 1, consists of a horizontally split casing containing a copper float which actuates the feed valve by means of a lever, as shown. As the working parts are all in the pressure space, stuffing-boxes have been omitted. The float and the control valve are the interesting features of the controller.

The copper float is heavy enough to withstand a cold-water pressure of five times the working pressure. When the boiler is in service, the upper half of the float is surrounded by steam of a temperature corresponding to the pressure of the steam in the boiler, but the lower half is surrounded by water that does not have a temperature equal to the pressure. Therefore, the temperature inside the float is a mean between that of the steam above and of the water below the floating line of the float. As the float contains a certain amount of volatile liquid having a boiling point lower than that of water, it vaporizes at the mean temperature existing inside the float and builds up a pressure approximately equal to the boiler pressure on the outside of the float.

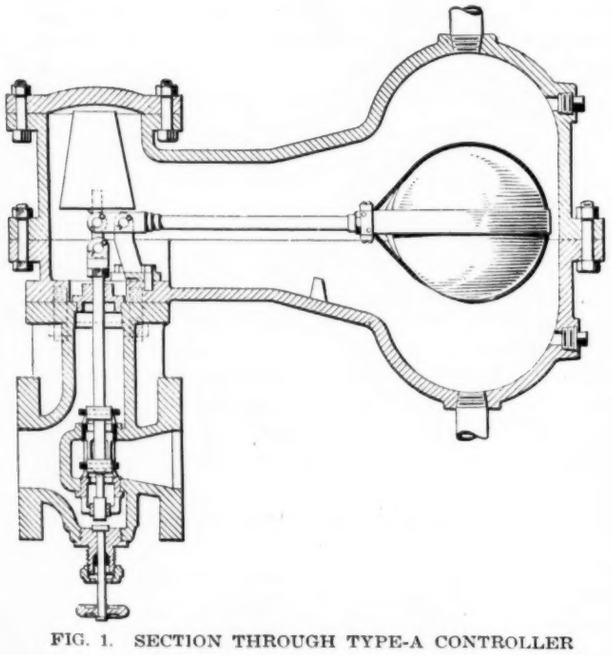


FIG. 1. SECTION THROUGH TYPE-A CONTROLLER

A balanced piston type of valve is used, both pistons being of the same diameter. This piston fits in a sleeve in which there are four V-shaped ports near its upper and lower ends. The central portion of the sleeve has three large openings, the area of which is considerably in excess of that of the upper V-ports. As the lower end of the valve sleeve only is threaded to its seat, it can be withdrawn without disturbing the valve or breaking any of the pipe connections.

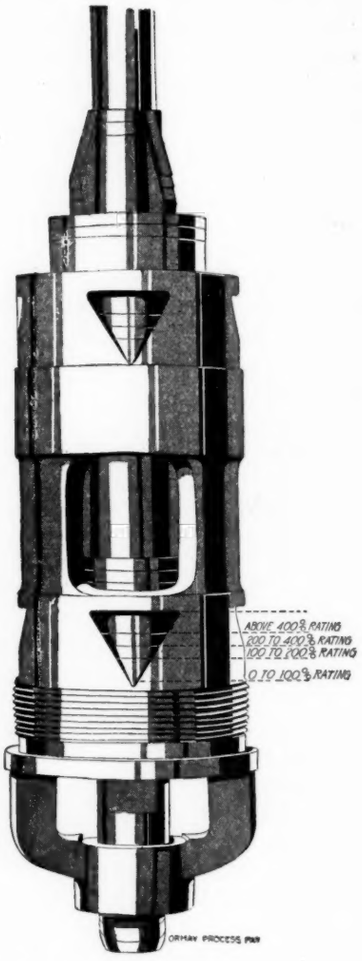


FIG. 2. DETAILS OF THE VALVE

The valve does not seat, but is designed to control a continuous flow of water through the V-ports. Fig. 2 shows the piston disks in three positions and gives a general idea of the different degrees of valve opening required to feed a boiler at the rating indicated and with a normal excess pressure on the inlet side. About $\frac{5}{16}$-in. lift takes care of the feed requirements for usual loads.

The movement of the valve stem is directly proportional to the movement of the water in which the float rides, but the flow of water through the ports is proportional to the amount that they are uncovered by the piston.

The controller shown in Fig. 3 operates on the same principle as that shown in Fig. 1. The casing, however, instead of being split horizontally, is provided with two

top openings through which the float lever and counterweight are placed in position. Instead of putting the counterweight on top of the valve stem, as shown in Fig. 1, a housing is provided on the end of the controller casing and the counterweight is placed in a horizontal position instead of in a vertical one. This casing is designed for high pressures up to 350 lb. and for the higher pressures is constructed of cast steel. The casing shown in Fig. 1 is for pressures up to 250 lb. and is made of cast iron.

The controller may be set at the corner of the boiler setting and connected to the boiler with the usual steam and water piping. The controller shown in Fig. 1 is used in conjunction with a water column; that shown in Fig. 3 is in itself a water column and is fitted with the usual try-cocks and gage-glass.

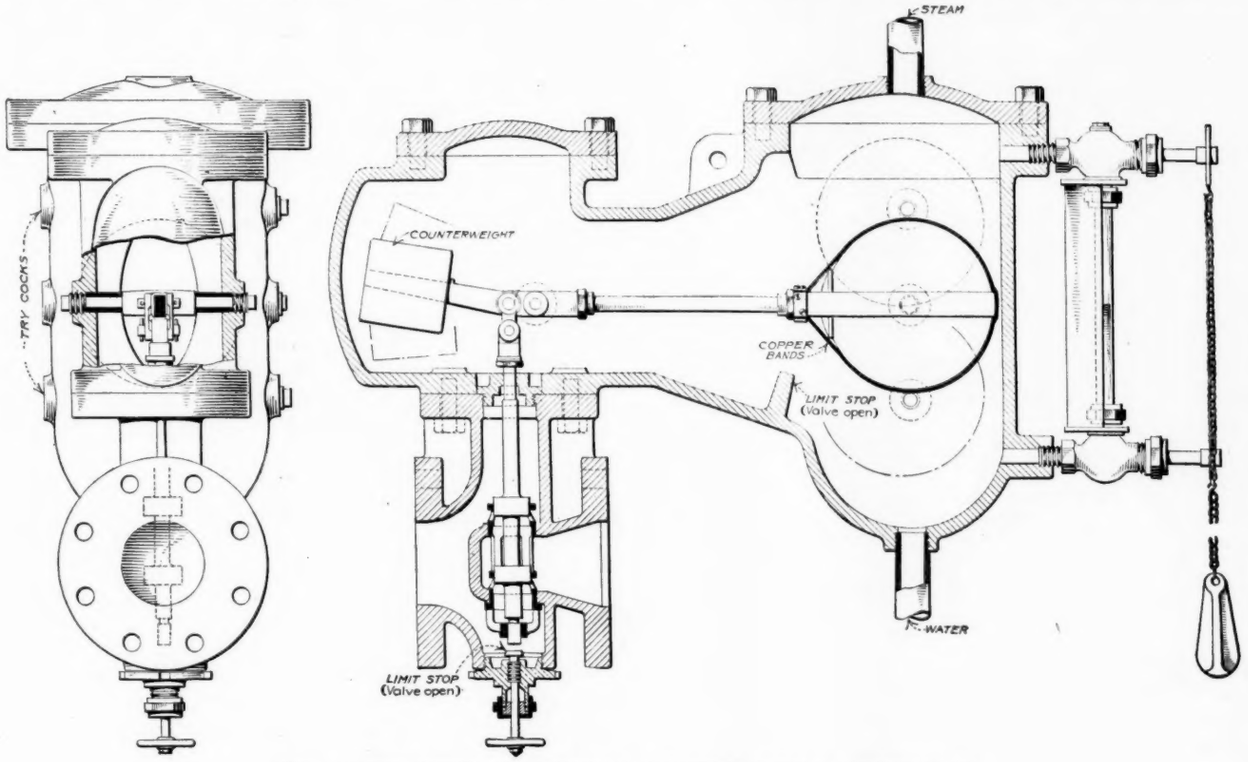


FIG. 3 END VIEW AND SECTION THROUGH TYPE-B CONTROLLER

Atmospheric Vapor-Absorption System

BY G. C. DERRY

In a power plant at Port Henry, N. Y., on the shores of Lake Champlain, a troublesome vapor condition existed in cold weather from cold air coming in and condensing the moisture in the warm air in the boiler room, which caused a fog so dense that the firemen could scarcely see their steam gages and water glasses from the floor of the boiler room. Several plans for getting rid of the vapor were tried without success. The coal supply was just outside the boiler room, and there was a continual opening and closing of doors as the firemen brought the coal in. The fog was so dense, in fact, that when the firemen started in with the coal, they had to shout in order to avoid running into each other, and it was difficult to get men to stay and work under such conditions. Water tenders had to be put on in order to watch the water gages from an elevated platform constructed in front of the boilers.

A condition existed which resembled the blowing of one's breath into cold air in the winter time, and it seemed to me that the logical thing to do was to bring the incoming air up to the temperature of the room or possibly a little higher, so it could carry off some of the vapor. Proceeding along these lines, a large heater and multivane fan were installed, which drew the air from the room, mixed it with some fresh air from outside and forced it through a duct system leading along the sides of the room and down each side of each door and up against the cold surface of the windows. The fan and heater were installed on an inclosed platform over the door which led to the coal pile, and advantage was taken of this platform—making it a ceiling of a room into which to pour a large amount of heated air.

The fan had a capacity of 33,000 cu.ft. of air per minute, and the air in the room was changed every three minutes. The heater was capable of heating this amount of air from 10 deg. to 158 deg. when supplied with steam at 60 lb. pressure. The system had the advantage of removing the steam in the winter and also providing a means of ventilation in the summer.

The owner has advised us that the system worked satisfactorily, removing every trace of the vapor even during the extremely cold weather last winter.

Most engineers would have a fit if cast-iron nuts were furnished for the valve chest and cylinder covers, yet one end of these studs is always in a cast-iron nut. But on that account there are no fits, showing that it makes a mental difference which end of the stud you are thinking about.—*Marine Engineering.*

Not because he loves cast iron less, but steel more.

Conditions in the Power Industry

BY LUDWIG W. SCHMIDT

A digest of the reports of the United States consuls on the power situation in the various parts of the world and the influence of the war upon this important industry. Also, see "Power," March 5, 1918.

THE electrical power development of the world outside the United States has been influenced by two distinct factors during the last three months. One has been the increasing demand for electrical power and the other the lack of funds to make the urgently needed extensions. As a result, most of the existing central stations report increased business and all say that they could do more if they had the necessary installation.

In Europe, where the immediate needs seem to have been largest, extensions have been made where urgently wanted so as not to cripple the activity of the national industries. Outside Europe, however, development has been held back, and there is plenty of evidence that many projects which should have been carried out during the present year have been deferred to a later time. Central stations in all parts of the world report that they have difficulty in making contracts for additional equipment and that where it has been possible to place the orders the contractors remain behind with their deliveries.

Norway seems to be an exception to the rule. The expansion of hydro-electric enterprise which has been characteristic of the economic life of that country during the last year continues during the present. Commercial Attaché Erwin W. Thompson writes from Copenhagen (C. R. 1.)[1], that it is proposed to develop 100,000 hp. from the Gaudefaldene waterfalls near Stavanger. The power to be obtained will be used principally for the production of carbide and for other electrochemical industries. To provide for the labor essential to the new industries it is intended to build a village near the falls.

Utilizing Water Power for Smelting Iron Ore

The same consul reports a scheme to utilize water power for the smelting of iron ore. Norway has large iron-ore fields which yield more iron than can be used in the country. This ore at the present time is exported to be smelted, but it is thought feasible to smelt it in the country. The beginning will be made with ore produced in the Braastad mines, near which 2500 hp. can be created (C. R. 3). As there is a lack of hydraulic and electrical machinery, it is expected that large quantities will have to be imported. Electrical smelting also will be resorted to in a new steel mill which is to be built in Risor, near Christiania. This mill is expected to turn out from 30,000 to 40,000 tons of steel every year. The power for smelting will be taken from the Hoge Falls, where from 150,000 to 200,000 hp. can be obtained. Only 22,000 hp. will be needed for the beginning (C. R. 64).

If the utilization of hydro-electric power for smelting should become more general in Norway, it is certain that this country will be in need of much machinery which, for a while at least, she most likely will buy either from England or from this country. The machinery for the Gaudefaldene scheme is to be supplied by England.

Most of the Norwegian electrochemical enterprises seem to have been operated with considerable success during the last year. The annual report of the Norsk Hydro, which controls 300,000 hp. and has a capital of $15,450,000, shows that this company has increased its net profit from $4,900,000 during 1916 to $6,650,000 during 1917. The business year covered by the report runs from July to June for each year (C. R. 33).

England Making Preparations for Post-War Development

In England all electrical-power development at present is influenced by the preparations made for the reorganization of all power supply which is expected to follow the war. With the possibility that great changes will be made in the production and distribution of power, local enterprises show little inclination to invest in new installations. Only the most urgent additions are made. New installation work is also hampered a good deal by lack of labor and materials which are needed more urgently somewhere else.

In the meantime the local power and traction companies are doing good business. The Glasgow Corporation tramways, for instance, have to report an increase in takings of $391,618 for the period from June 1 to Nov. 30, 1917, in comparison with the same period of 1916. During the six months of 1917, 212,961,987 passengers were carried as against only 192,399,712 in 1916 (C. R. 4). No new enterprises of any extent are reported, but Consul J. S. Armstrong, Jr., writes from Bristol that the municipal authorities will be compelled to extend the local electrical plant by installing a 6000-kw. turbo-alternator, four water-tube boilers and switch gear. The additional installation is made necessary by the increased demand for electrical power.

Lack of Electrical Engineers in Spain

During the last year Spain has had a fair share of the so-called war prosperity, which in many cases has made necessary additions to the existing generating stations. It seems to be generally realized that that country in the future will have to rely more than ever on its own industrial resources, which in turn will necessitate the provision of better electrical-power facilities than heretofore. So far there has been a lack of sufficiently trained Spanish electrical engineers. This deficiency will now be eliminated by giving increased opportunities for the study of electrical engineering. The City of Barcelona therefore has added a special Institute of Electrical Industries to the Industrial School of that city, the influence of which should very soon be felt in the electrical industry of the country (C. R. 11).

Italy has made good use of its great hydro-electric possibilities during the war. Consul Joseph E. Haven in Turin points out in this respect that many factories in Italy which formerly were operated by steam power are now using electrical power and that electricity has

[1] C. R. indicates "Commerce Reports" of 1918.

become the standard motive force. This change has been made possible by the erection of big electrical central stations, which in some instances supply power over distances of hundreds of miles. Before the war Germany supplied most of the electrical-power machinery in use in Italy. Since Italy entered the war, connection with Germany, of course, has been broken off, and now American, English and Swiss machinery is used in preference. Also the Italian electrical industry has made considerable progress (S. C. R., Feb. 8, 1918).[2]

The industrial census of Africa for the year 1915-16 has shown again the great progress made in the use of electrical power in that country. There were in South Africa proper 1214 establishments using electrical power to the extent of 121,229 hp., as against only 689 using 564,664 hp. generated by steam, 440 using 5985 hp. generated by oil engines, 181 using 6266 hp. generated by gas and 152 using 3759 hp. generated by water. In the Transvaal 430 establishments used 84,634 hp. generated by electricity and 226 used 294,956 hp. generated by steam (C. R. 6).

Electrical Power Industry in South America

The last year has brought much activity to the electrical power industry of South America. Many new industries have sprung up to supply those articles which the South American countries cannot buy any longer from Europe owing to the war, and these industries had to be supplied with cheap and reliable power. So an increased use has been made of electricity. In Venezuela an attempt will be made to use one of the waterfalls in proximity to Caracas. Consul Homer Brett in La Guaira says that this development will be carried out by American capital. The water power to be used is that of Naiguata Falls, which have a drop of 3373 ft., and it is expected that 8000 hp. will be created from this source. The necessary investment will amount to approximately $1,000,000, which will be obtained with the assistance of American banks (C. R. 6).

State ownership of electrical enterprises has advanced another step in Uruguay, where the government just now has acquired its sixth electrical power plant. The station in question is that of Mercedes, which was the property of the firm of Preve y Hermanos. The government also owns electrical central stations in Montevideo, Colonia, Canelones, Maldonado and Pando. All government plants are under the control of the Administracion General de las Usinas Electricas del Estado (C. R. 40).

Consul William Dawson in Montevideo reports in the same connection (C. R. 41) that all the state electrical plants are burning oil fuel, which under a special contract is supplied by the West India Oil Co. Under its agreement with the company the state has the right of preferential treatment as to supplies and has just now made an order that the company keep a reserve of 5000 tons of oil, to be held for use of the government.

Consul Charles L. Latham in Kingston, Jamaica, says that there is a demand in that island for small individual power plants to be installed in country houses. Electrical power so far is available only in the cities. Farmers and planters realize well the great advantages to be derived from the employment of electricity in the operation of farm machinery, the lighting of houses, etc. Power outfits should consist of a kerosene engine, a dynamo mounted on the same shaft preferably, and a bank of storage batteries. The price should be approximately $400 (C. R. 38).

Industrial Activity in Japan and China

The enormous increase in industrial activity in Japan resulting from the war has caused a great demand for electrical power, which has necessitated the erection of many new power stations. Although there is, strictly speaking, no boom in power development, business nevertheless has been very active and the number of electrical enterprises has increased 50 per cent. There are now 674 electrical stations in Japan having a combined capital of $339,422,119. The combined power supplied by these stations has a daily average of 922,940 kw., of which 700,870 kw. is generated by hydro-electric stations. The remainder is generated mostly by steam. During the last year steam generation has made greater progress than water-power generation. There was a total increase of the average daily power supply of 131,706 kw. (C. R. 36).

The activity in the electrical industry in eastern Asia, however, is not confined to Japan only. From a report by Consul General P. S. Heintzlman in Canton, China, it appears that China has had its share. There has been apparently a good deal of difficulty in securing the supply of electrical-power-station machinery in China during the last three years, which has hampered considerably the development of the industry. The Kwangtung Electric Supply Co., for instance, has contemplated an extension of its power equipment for a long time. It has now been possible to place a contract with a firm of American engineers for the purchase of two American high-pressure condensing turbo-alternators, rated 2500 kw. three-phase 60-cycle 2300-volt; one American high-pressure noncondensing turbo-generator, 35 kw. 125-volt direct-current; and switchboards, pumps and other accessories. The contract also provides for four 750-hp. Babcock & Wilcox boilers. In all, $433,500 in gold will be spent for the new equipment.

The Kwangtung Electric Supply Co. is a Chinese enterprise which was established during 1909 with a capital of $480,000, American money. Its monthly takings are now approximately $60,000. The plant has been a success from the start, and will be the second of importance in China after the completion of the extensions now ordered.

Central Stations in South China

South China contains a number of electrical central stations. As the most prominent of these the consul mentions the following: Kowkong, Kongmoon, Sainam, Taileung, Sheklung, Chanchuen, Sunning City, Suncheng, Fatshan, Shin Hing, Siulam, Shekki and Kiungchow, all in the Kwangtung Province, and Wuchow and Nanning, in the Kwangsi Province. Most of the electrical equipment of these stations is of American manufacture, though most of the machines were purchased from England. The plant in Sunning City is equipped with Swedish machinery. Most of the stations in question are private enterprises. Those in Fatshan, Sainam, Shin Hing, Nanning and Wuchow are owned by the

[2] S. C. R. indicates "Supplement, Commerce Reports."

Chinese government. The motive power is provided practically everywhere with the help of internal-combustion engines. Now experiments are made with native coal, and the new plant in Canton will be the first burning Chinese coal under its boilers (C. R. 4).

The war also has brought much business to the central stations of India. Southern India to-day has three large electric-power companies, says Consul Lucien Memminger, of Madras (C. R. 44). These are at Madras, Bangalore and Hyderabad. So far only one electric railroad is operated in the district of the consulate, which is that in Madras. This is 28 miles long, but the war has made necessary an extension of the system which may be taken in hand very soon. The report tells of several new electric railroad schemes. One of these refers to a line from Kulaskharapatnam to Tiruchendur in South India. This line will have a length of 29 miles and it will be built by an English firm. Electrical expansion in India suffers as anywhere else from the lack of available capital. So it seems that two projects—one to establish railways in Mysore and the other to extend the power station at the Cauvery Falls—both of which have been worked out by S. G. Forbes, an American engineer and chief electrical engineer of the Mysore government, will have to wait. The estimated cost of these undertakings will be $3,147,000. The Mysore power undertaking has just received permission from the government to install an electric-lighting system in Madura. Orders have been placed in the United States for hydro-electric machinery at a value of over $1,000,000 to be used in connection with the Andhra Valley development executed by the Tata Hydro-Electric Power Supply Co.

Evertite Sta-Lok Nut

A nut that is likely to work loose is a source of danger, trouble and anxiety to the user. Numerous devices have been employed to prevent nuts from loosening, some being home-made and others patented. A recent addition to the number is known as the "Sta-Lok" Nut, manufactured by the Evertite Nut Corporation, Detroit, Mich.

This nut will not loosen under heavy stress, nor from violent or prolonged vibration, such as is experienced

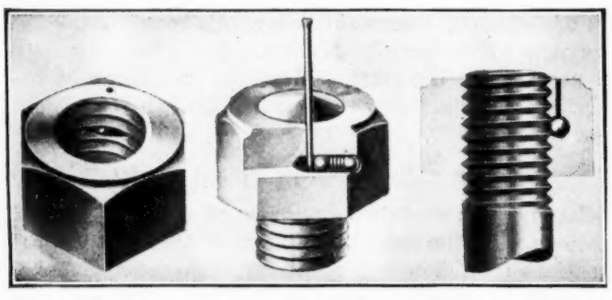


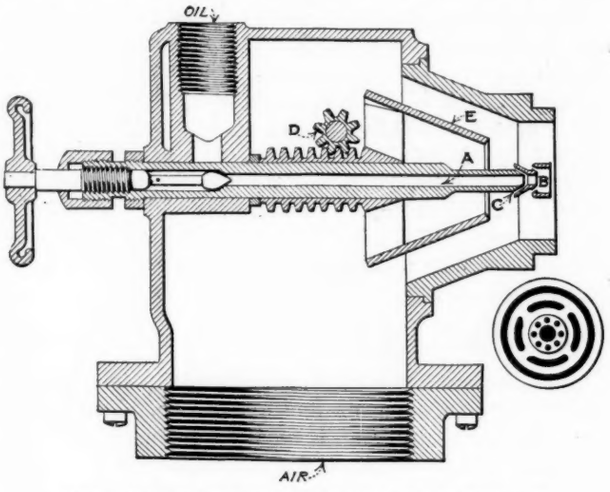
FIG. 1. THE NUT. FIG. 2. UNLOCKING. FIG. 3. LOCKING

with some types of high-speed machinery. It looks like any other nut from the outside. On the interior, however, there is a hardened steel ball that runs in a groove between the bolt threads, Fig. 1. This ball is kept in contact with the threads, Fig. 3, by a spring, and when the nut tends to unscrew the spring forces the ball to wedge in the threads, which tightens the nut and so prevents it from working loose.

The only way to remove the nut is to release the ball from its lock position, which is done by inserting a pin through the keyhole shown in Fig. 2. Should the keyhole become filled with dirt it is easily cleaned by inserting a small pin or wire.

Lindsay Low-Pressure Oil Burner

The Lindsay oil burner has recently been placed on the market, and although it was primarily designed for use in assay and metallurgical plants it will doubtless be



SECTION THROUGH LINDSAY LOW-PRESSURE OIL BURNER

found suitable for use by engineers for heating small furnaces, etc. It has a central channel *A* through which the oil flows; the oil is discharged through an enlarged orifice *B* in a thin circular film. It is caught by a rotating blast of air and thrown from the nozzle as a fine swirling mist. The burner is manufactured by the Mine and Smelter Supply Co., New York City.

Part of the air supply passes through the tip of the innermost orifice at *C*, thus preventing the clogging of the oil line. The burner will work successfully on any oil from a heavy one of 18 deg. Baumé to the lightest gas oil. As there are no delicate parts to clog, it is not necessary to take the burner apart frequently for cleaning, although all parts are accessible if for any reason it is desirable to open the burner. The oil consumption is low, running from 1 to 1½ gal. per burner per hour for the smaller sizes, up to 2 gal. and up for the larger ones.

The air pressure required for the Lindsay low-pressure burner is from 6 to 8 oz. On account of the burner construction this pressure gives perfect atomization, while the oil is fed to the burner by gravity. The air supply is controlled by merely turning a regulating adjustment situated on the side of the burner and which does not get hot. This can be done instantly and while the burner is in use.

As the adjustment is turned that reduces the quantity of air, a movable cone *E* decreases the area of the air vent, so that the pressure remains constant, though the volume is less. This prevents loss of efficiency, which would occur if a less quantity of air were permitted to go through the same sized orifice. This movable cone is regulated from the adjustment on the side of the burner through a rack and pinion *D*, and is held in position by a pawl and spring so that the adjustment will not change.

Where Does the Heat Go?

Of the total amount of heat energy represented by the coal fired in a boiler furnace, only from 6 to 15 per cent. is obtained in the form of useful work at the belt wheel of the engine. This article shows where and how the heat is lost.

ONE pound of good coal has a heating value of 13,500 B.t.u.; but when that coal is burned under a boiler and the steam produced by it is used in an engine, the work obtained at the belt is only a small fraction of the energy contained in the fuel. The reason is that the greater part of the heat is lost in various ways.

A part of each pound of coal drops through the grates and is carted away with the ashes. As this coal is not burned, its heating value is not given up, and heat is thus thrown away. The loss in any particular case will depend on the kind and grade of coal, the form of grate and the skill of the fireman. As an average, the loss may be taken as 1 per cent., or 135 B.t.u.

The furnace is inclosed in brick, and the steam drum is protected by a nonconducting covering; but even these precautions cannot wholly prevent heat from being radiated from the boiler. The amount thus lost may be assumed to be 5 per cent., or 675 B.t.u.

The two losses just mentioned, however, are small when compared with the loss due to the escape of the hot gases at the top of the chimney. About 2970 B.t.u., or 22 per cent. of the heating value of the coal, passes away through the chimney.

Of the 2970 B.t.u. thus lost, much is used in heating the air supplied to burn the coal. The air entering the ashpit has a temperature of, say, 60 deg. F., but the gases escaping at the top of the chimney have a temperature of 500 or 600 deg. F. This large increase of temperature requires heat, which is taken from that developed by combustion of the coal.

The chimney gases also contain steam, formed by the combustion of the hydrogen in the coal as well as by the vaporizing of the moisture in the coal and in the air supply. A part of the 2970 B.t.u. is accounted for by the escape of this steam.

Further than this, there may be unburnt carbon and hydrogen in the chimney gases. If all the carbon is not burned to carbon dioxide (CO_2) and all the hydrogen is not burned to steam, the escape of these unburnt combustibles represents a loss of heat. The loss due to combustibles in the chimney gases accounts for the remainder of the 2970 B.t.u.

The three items of loss thus far considered total 28 per cent., which represents the boiler loss. The difference between this and 100 per cent. is 72 per cent., which is the boiler efficiency; that is, the boiler puts into the steam 72 per cent. of the heat it receives from the coal. At this efficiency, therefore, the boiler utilizes $13{,}500 \times 0.72 = 9720$ B.t.u. per pound of coal burned.

A part of the heat in the steam—say 10 per cent., or about 1000 B.t.u.—is needed to run the feed pump and other auxiliaries; but when these are run noncondensing, it is possible to reclaim about 780 B.t.u. by passing the exhaust steam through a feed-water heater. In this way the amount of heat put into the steam for each pound of coal burned is 10,500 B.t.u. When the steam is conveyed through the main pipe to the engine and pumps, there is a further loss due to radiation and leakage, amounting to about 210 B.t.u.

The pipes and cylinders of the auxiliary apparatus are often left bare or are not well covered, and of the 1000 B.t.u. delivered to them, about 3 per cent., or 30 B.t.u., is lost by radiation. As 780 B.t.u. is reclaimed in the heater, it follows that $1000 - (780 + 30) = 190$ B.t.u. is lost in the exhaust from the heater.

Of the 10,500 B.t.u. in the steam, $1000 + 210 = 1210$ B.t.u. is accounted for by the radiation losses and the demands of the auxiliaries. The remainder, or $10{,}500 - 1210 = 9290$ B.t.u., is delivered to the engine. Leakage and radiation from the steam chest, cylinder, etc., will cause a loss of about 3 per cent., or 280 B.t.u., so that the heat left to be converted into work is $9290 - 280 = 9010$ B.t.u.

A good modern condensing engine will probably produce a horsepower on 2 lb. of coal per hour, or half a horsepower on 1 lb. of coal per hour. A horsepower is 33,000 ft.-lb. per min., or 1,980,000 ft.-lb. per hour,

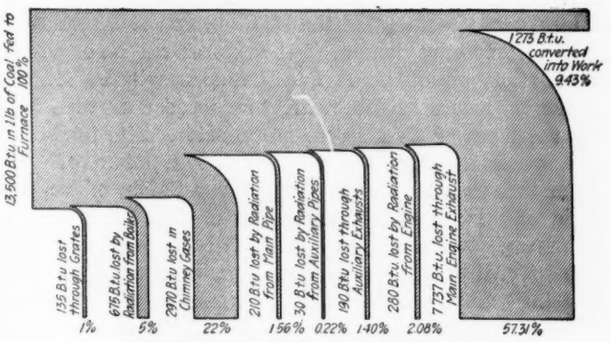

13,500 B.t.u. in 1 lb. of Coal fed to Furnace 100%
135 B.t.u. lost through Grates 1%
675 B.t.u. lost by Radiation from Boiler 5%
2970 B.t.u. lost in Chimney Gases 22%
210 B.t.u. lost by Radiation from Main Pipe 1.56%
30 B.t.u. lost by Radiation from Auxiliary Pipes 0.22%
190 B.t.u. lost through Auxiliary Exhausts 1.40%
280 B.t.u. lost by Radiation from Engine 2.08%
7 737 B.t.u. lost through Main Engine Exhaust 57.31%
1 273 B.t.u. converted into Work 9.43%

DIAGRAM SHOWING HEAT LOSSES

and as 778 ft.-lb. is equivalent to 1 B.t.u., a horsepower requires $1{,}980{,}000 \div 778 = 2545$ B.t.u. per hour. As the engine is assumed to produce half a horsepower, it will use $2545 \div 2 = 1272.5$, or, say, 1273 B.t.u. per hour. If only 1273 B.t.u. is utilized in producing power, the remainder, $9010 - 1273 = 7737$ B.t.u., represents the heat discharged into the condenser and carried away by the circulating water and the condensate.

Not all of the 1273 B.t.u. converted into work is available at the belt wheel, for friction will waste about 8 per cent., even in a good engine. If the engine is assumed to have the high mechanical efficiency of 92 per cent., therefore, the heat equivalent of the work available at the belt will be $1273 \times 0.92 = 1171$ B.t.u. Thus, from 13,500 B.t.u. put into the furnace in a pound of coal, only 1171 B.t.u. is converted into useful work. This is equivalent to $1171 \div 13{,}500 = 0.0867$, or $8\frac{2}{3}$ per cent., of the heat in the coal.

The accompanying diagram shows graphically the various heat losses, expressed as percentages of the heating value of the coal. It is evident that the largest losses are those due to the hot chimney gases and the exhaust steam from the engine, and wherever the losses are greatest, opportunity for saving is greatest.

Federal Inspection of Power Plants

Power Plants Must Be Efficient As Well As Safe
The Needlessly Wasteful the Last To Get Fuel

IT HAS been definitely determined by the United States Fuel Administration to institute a system of classification of power plants, based upon the care and efficiency with which they are operated, and the idea has received the approval of fuel administrators in New England, Connecticut, New York and Pennsylvania. The details have been worked out by David Moffat Myers, Advisory Engineer of the United States Fuel Administration.

It is estimated that from 25,000,000 to 50,000,000 tons of coal per year can be saved in power plants, simply by the more careful and intelligent use of existing apparatus and the elimination of easily preventable waste. To effect this purpose an Administrative Engineer will be appointed in each industrial state, to be attached to the office of the State Fuel Administrator. W. R. C. Corson, of the Hartford Steam Boiler Inspection and Insurance Co., is to be the engineer for Connecticut; E. N. Trump, vice president of the Solvay Process Co., for New York; Thomas R. Brown, of the Westinghouse Air Brake Co., of the Pittsburgh district; and Walton Clark, vice president of the U. G. I., of the Philadelphia district of Pennsylvania. Other states will be organized as fast as possible. A questionnaire will be sent by these engineers to the owner or operator of each fuel-operated power plant in the state, asking him to furnish the administrator within a stated number of days such information as the type and number of boilers; kind of service or product; kind of draft and method of firing; amount and kind of coal burned during the preceding 12 months; proportion used for power, heating and process work; amount of purchased power; whether records of coal consumed, water evaporated and flue-gas analysis are kept; type and size of steam-using units; what provisions are made for weighing coal and water, and what records are kept; what provision is made for heating feed water; if means are provided for measuring the draft over the fire and for determining excess air by gas analysis; if dampers are provided for equalizing the draft in the furnaces; if there is a convenient means for regulating the draft by the main or uptake dampers; if there is an automatic damper regulator in working order; what provision is made for keeping soot and ashes from boiler-heating surfaces; whether the grates are warped, broken or otherwise defective; whether there are leaks in boiler settings, openings between boiler and setting, badly warped fire-doors, etc.; if heat-radiating surfaces are covered; if the exhaust steam from noncondensing engines is used and to what extent; if live steam at low pressure is used in the plant and for what purposes; if a competent man is detailed to supervise the work of fuel conservation in the boiler and engine rooms and the transmission and use of power in the factory.

Arrangements have been made whereby inspectors of the steam-boiler insurance companies, state factory inspectors, engineering students from technical colleges, volunteers and others will visit these plants and verify the answers given in the questionnaire. Each plant will be given a rating, based upon the data so obtained. The ratings will be divided into five classes, and in case of a fuel shortage the plant that has been found to be needlessly wasteful will be one of the last to be allowed to draw upon the available supply.

It is recognized that plants must be dealt with as they are found. No extensive and expensive installations of more efficient apparatus will be expected, but there are many economies that can be brought about by stopping leaks in boiler settings, repairing baffles, covering heat-radiating surfaces, trapping outlets, returning drips and making an intelligent use of the exhaust. A plant will be judged, not on its inherent efficiency as a plant, but by the use which it makes of its own conditions and opportunities. The whole attitude of the administration will be one of suggestive helpfulness rather than of coercion. The inspectors who visit the plants to verify the questionnaires will in many cases be able to give sound advice, and the State Administrator will be furnished with a list of approved professional consulting engineers to whom power-plant owners may turn for more extensive consultation.

The Fuel Administration is also preparing a series of official bulletins on Steam and Fuel Economics. These will include boiler and furnace testing, flue-gas analysis, saving steam in heating systems, boiler-room accounting systems, saving steam and fuel in industrial plants, burning fine sizes of anthracite, boiler-water treatment, oil burning, stoker operation.

Burning Natural Gas Under Boilers

BY CHARLES JABLOW

On account of the present interest in fuel conservation it may be interesting to note the saving effected in one plant from a study of the operating conditions.

The plant, containing 770 rated boiler horsepower, was using as fuel natural gas, at a pressure of over fifteen pounds. Three of the boilers had four burners each. It was found by several evaporation tests that by reducing the pressure to about two or three pounds the equivalent evaporation was changed from 0.471 to 0.494 lb. per cu.ft. of gas, the highest heating value of which was 619 B.t.u. per cu.ft. But with this pressure reduction there was a reduction in the boiler horsepower from 212 to 148, partly because the gas main leading to the plant is only 3 in. in diameter and the pressure change was made at a gas regulator about 1000 ft. distant, so that with the lower pressure the capacity of the line was reduced too much. I recommended that the regulator be moved to the plant and that the 3-in. line be subjected to the high pressure of the main. An additional burner was put under each boiler at the same time, and our expectations relative to the performance of the boilers were fulfilled and the rating of the boilers was easily developed.

The fuel bill for the last few years has been about $10,000 annually, and the saving by these changes amounts to about $450 per year.

Editorials

Government Insistence Upon Power-Plant Efficiency

EVER since its foundation *Power* has insisted upon Governmental regulation of power plants. It holds that the owner of a factory or a department store has no right to invite the public into a building in the cellar of which are boilers upon the safety of which no competent authority has passed, operated by laborers selected for their willingness to work for meager pay rather than for their knowledge of the forces with which they are dealing. Regulation and inspection exercised by foreign governments have reduced casualties until the number of those in the United States is by comparison lamentably high in proportion to the number of boilers in use.

It appears to be axiomatic that it is not only the right but the duty of the Government to look after the safety of the citizen. Several years ago we ventured a suggestion that the time might come when the Government would insist upon efficiency as well as safety in the operation of power plants. If a boiler explosion is a communal disaster, adding, through its destruction of buildings, plant and material, its interruption in production and reduction of output, in increased rent and insurance and prices of product, and in care of the injured and dependent, to the burdens of the community, how much more of a communal disaster is a sustained waste, going on year after year, using up the resources of the country and paid in the final analysis by the ultimate consumer. The idea has found expression by others and would have found justification and adoption in the course of ordinary events.

But the war has produced a condition of fluxibility in which the fixed patterns and formulas of an old conservatism are torn loose and jostled about with a chance of setting down upon lines which are sound and right and capable of producing results. And so, quite naturally, when the scarcity of fuel becomes pressing the people—that is the Government—say: "Why should this man be allowed, through simple carelessness, to burn twice as much coal as he needs, making his product (if its selling price is based on its cost as it should be) cost more to its users, using up man-power and railway facilities to get coal to waste while others suffer for the want of it?"

Over forty per cent. of the coal mined is used in industrial plants. A saving of even ten per cent. in this field would go a long way toward making up the shortage. The Fuel Administration has resolved to put this saving into effect. An engineer will be accredited to the Fuel Administrator of each of the industrial states, and under his direction a questionnaire will be sent to the owner or operator of every fuel-operated power plant in the state. The replies to this questionnaire will enable the state engineer to determine whether the plant is being operated with care and intelligence or needlessly wastefully. Inspectors will visit the plants, verify the answers returned and offer helpful suggestions. No insistence will be put upon the installing of more efficient apparatus, but an effort will be made to get the best results out of present equipment with such simple improvements as can be made under existing conditions and improved methods of operation. In the light of the information thus obtained, the plants will be classified, and those which use their fuel with the least care and intelligence will be the last to get any when the shortage comes. The attitude of the Administration will, however, be suggestive and helpful rather than coercive. The inspectors will not be called upon to advise as to possible improvements in apparatus and methods. The state administrators will be prepared to recommend reliable professional engineers for those who care for more extensive advice.

One of the beneficial results of this action will be to direct the attention of the office to the power plant. In the interim allowed between the receipt and the filing of the questionnaire, the owner or his representative will be interested to get the plant into as creditable a condition as possible so as to get as far as possible from that lower stratum which will be the first to be deprived of coal. This will be the opportunity of the engineer to get much-needed apparatus and to have repairs and overhauling done, his recommendations for which have not met with a favorable response in the past.

The movement ought to result in the improvement of a multiplicity of plants and the saving of many tons of coal, and should receive the hearty approval and cooperation of plant owners and operators and of fuel administrators everywhere.

Work or Fight

THE latest amendment to the selective draft law, recently announced by Provost Marshal General Crowder, whereby, after July 1, every man of draft age must either go to work in employment essential to winning the war or join the fighting forces in France, is the most encouraging news that has come from the Provost Marshal's office for some time and should be received by every American with red blood in his veins as a wholesome change in our military policy. According to the order gamblers, race-track and bucket-shop attendants, fortune tellers and idlers head the list, followed by waiters, bartenders, theater ushers and attendants, passenger-elevator operators, attendants at clubs and hotels, domestics, clerks in stores, baseball players, jockeys, professional golfers, and other professional sportsmen. Looking this list over, it would appear that the Provost Marshal has an excellent insight into nonessential industries as far as men in their prime are concerned, since many of those listed, especially the first five, the nation can well do without not only in times of

war, but in peace also, with profit to itself. The other occupations might be considered healthy men's jobs when the nation is at peace, but they certainly can all be filled by women or men too old to enter the industries or the fighting ranks or dispensed with entirely when the nation is facing a shortage in its man power like the present.

We have long passed the time when we can afford to allow able-bodied men to loaf away their time in poolrooms, on park benches, in dance halls and cabaret shows, while millions of others are working overtime in our industries to supply the sinews of war for other millions we are sending to the battle front to suffer all the privations of modern warfare and die if need be to make the world safe for democracy.

There has been considerable discussion as to what are nonessential industries and who is able to distinguish between the nonessential and essential. However, General Crowder seems to have attacked the problem by a process of elimination and has excluded the least essential at first. Although his first step is a modest one, there is no doubt that if the war continues for a considerable period longer this ruling will be extended to other industries until every able-bodied American citizen will be either in the military forces of the country or engaged in industries essential to the war machine. This latest ruling should give assurance to many that whatever may be termed semiessential industries of the country will not be robbed of their employees until at least every able-bodied loafer has been put to work or fighting, and that the Provost Marshal intends to meet the emergency with as little hardship to the country's industries as possible.

Boiler Settings

WITH the advent of high combustion rates on stokers and the quest for economical production of steam, to say nothing about smoke abatement, the matter of boiler furnace design became one of the important factors in power-plant practice. The wider use of the Middle-Western coals and lignites, both high in volatile, together with the desire in many quarters to burn these fuels at high combustion rates, gives added significance to the boiler setting or combustion volume.

In 1913, when the water-tube boilers in the Two Hundred and First Street station of the United Electric Light and Power Company, New York City, were set ten feet from bottom of front header to the floor line, there was general explanation. Today, engineers will do much to overcome any obstacle that stands in the way of setting this type of boiler less than twelve feet above the floor, even for Eastern low-volatile coal and a combustion rate of 250 per cent. builder's rating of the boiler. One finds boilers set thirteen and even fourteen feet here in the East, while boilers of the Stirling and Connelly types are being set with the center of the mud drum anywhere from eight feet for high-volatile coal to over eleven feet for lignite, when burned on underfeed stokers. Not only do engineers recognize the value of large combustion volume, but one finds all builders of stokers urging a minimum height for settings, varying with the boiler and coal and combustion rate. In those plants which change over from hand-firing to stoker-firing, nearly all builders of stokers will refuse the job if the prospective purchaser insists on too small combustion volume.

The articles now appearing in *Power* on the subject of boiler settings are valuable not only because they show what is current and excellent practice for high-volatile coal particularly, but because the numerous drawings carry all important dimensions, and in addition numerous performance data will be presented.

Concrete Boilers Next

CONCRETE construction has entered many fields of commercial enterprise, and although at one time opinions might have been held that it was suitable only for sidewalks and not any too good at that, the art of concrete construction has developed into broad channels, so much so that entire buildings are made of it. Its latest application is that of concrete ships. Now, according to the *San Francisco Chronicle*, cement may be used in the construction of boilers in the near future, as it is understood that an experiment will be made at the Union Iron Works. The report says that considerable figuring has been done and numerous sketches have been made, and that a boiler will be constructed shortly. It is stated that it is expected that with the exception of the boiler shell there will be but little change, and instead of one thick boiler sheet the new construction of shell is to consist of two thin sheets of steel, probably one-quarter inch in thickness, and these will be fastened together, leaving between them two or three inches of space, which will be filled with a high-grade cement.

In these days of progress and invention one is not safe in asserting that this or that proposed idea will not work out satisfactorily. It is only a few years ago that the practicability of the steam turbine was earnestly disputed. It is only a few months ago that the practicability of building a concrete ship was seriously doubted, and although it is early to state whether the concrete ship will be a success as compared with steel-ship construction, the odds are in its favor. So to condemn the concrete boiler before the idea has been tested out would be, perhaps, premature, although one is inclined to wonder what will occur to the concrete when the boiler expands from a cold state to the temperature it will have when under working pressure.

There are 2,078,222 now in the Army; a million men ready to embark; ninety thousand sailed in the first ten days of May. All thoroughly equipped. America can raise an army of five million this year without going outside of Class One.—*Representative Caldwell, of the Military Affairs Committee, to the House.*

The American shipyards are averaging one steel ship a day. May output more than 200,000 tons. Two ships just launched were completed from keel to aërial in fifty-five days, and one in fifty-seven days. In the next eighteen months six hundred ships will be put in commission on the West Coast alone. Ten steel ships were finished and eighteen others launched in one week.

Yes, indeed, the Yanks are coming.

The latest advices from Boston are to the effect that Garabed Giragossian is suffering from an attack of constipation of energy.

Correspondence

North Dakota Lignite for Boilers

Your editorial and Henry Kreisinger's article on the combustion of North Dakota lignites, in *Power*, Apr. 30, are interesting and instructive. To those not familiar with the fuel it may appear that our lignite is not suitable for steam coal except with a specially designed furnace and grate. All the power plants in the western part of this state are using lignite successfully in ordinary furnaces provided with suitable grates, and we are obtaining efficiencies equal to those had when burning bituminous coal in the eastern part of the state, where, I have noticed, it required 78,000 B.t.u. in the coal for generating one kilowatt-hour. Under the same conditions with lignite we are generating a kilowatt-hour on 61,000 B.t.u. These figures are based on units that consume 40 lb. of water per kilowatt-hour delivered to the circuits and Eastern coal containing 13,000 B.t.u. and lignite 7000 B.t.u.

The same conditions prevail in flour making when comparing heat units required per barrel in Minneapolis with mills operated by lignite in this part of our state. It will therefore appear that here is a reason for suggesting a furnace for burning bituminous coal more efficiently.

The reason that our lignite is not used more extensively in the eastern part of North Dakota and neighboring states is the cost of transportation. It seems that the railroads have not favored it, as the rates on lignite from the mines to the eastern border of the state, a distance of about 210 miles, is $1.25 the ton; and in the next zone east of the border line the rate is $2.15 the ton; the freight on lignite to St. Paul and Minneapolis, a distance of about 500 miles, was about equal to the cost of Pennsylvania slack coal laid down there before the war.

On the border line the prices of Pennsylvania slack and our lignite were about equal and nobody would give the latter any consideration. No doubt the railroads took the advantage of shipping all our grain and stock to Minneapolis, St. Paul and Duluth and had cars returned this way loaded with coal from the harbor at Duluth. The rates on coal from Buffalo to Duluth via the lakes is very low. There was no market for our lignite, but since the shortage of the Eastern coal and congestion in transportation had been severely felt, people living in these zones have begun to look in our direction for their next winter's fuel supply.

The railroads now have the lignite rates under consideration, and the real value of our low-grade fuel will soon come to its right.

In this part of our state the poor man's fuel for domestic use is lignite. Those who can afford to burn anthracite do so regardless of its cost. Some would abuse lignite to a great extent even if we have beds 8 to 18 ft. thick, covering over 30,000 square miles. Some of this is surface coal that contains about 6000 B.t.u. per pound.

The largest mine in the state is in Burleigh County, the coal from which runs on an average of 7000 B.t.u. The best coal known to the writer is in Mercer County and runs on an average of 7500 B.t.u. A recent sample showed a commercial heating value of 8058 B.t.u., 30.6 per cent. moisture, 5.3 per cent. ash, 31.9 per cent. volatile matters, 32.2 per cent. fixed carbon and no sulphur. The same coal dry showed 11,611 B.t.u., 7.7 per cent. ash, 45.9 per cent. volatile matter and 46.4 per cent. fixed carbon.

Under fair conditions one pound of this will evaporate 6.25 lb. of water from and at 212 deg. F. This is equal to evaporating 10.86 lb. of water from one pound of coal containing 14,000 B.t.u., but to obtain such efficiency from lignite the volatiles or gases must be ignited in the furnace during their course of travel over the bridge-wall and through the combustion chamber. Forced draft and a near balanced draft is required, but the force of the draft under the grate is the most essential point to be adjusted.

Mr. Kreisinger suggests a large air space for grates of the inclined type. The same idea appealed to me, but I had to reverse myself, and I am now constantly cutting down the air space; I am now burning lignite on a flat sawdust grate having only 11 per cent. air space, and by doing so can maintain a higher air pressure under the grate. Lignite does not require a large volume of air for its combustion—about 75 cu.ft. of air per pound of lignite is sufficient. The clinkers accumulating on the grate from a lignite containing little sulphur are porous, and air passes through them quite freely with high air pressure under the grate. By keeping a few inches of water in the ashpit, there is little fire below the grates. The first set of sawdust grates, installed 12 years ago, is still in service.

It is not advisable to fire a boiler above its rated capacity when efficiency is considered, and with a ratio of 1 sq.ft. of grate surface to 50 sq.ft. of heating surface 40 lb. of lignite can be burned economically per square foot of grate surface per hour. With such conditions a flue-gas temperature of about 450 deg. F. with an average of 12 per cent. CO_2 can be maintained. Boilers equipped with economizers may be forced to a great extent as the excess heat in flue gases would not all be wasted.

When burning lignite the combustion chamber fills up rapidly with small particles or sparks from the fuel on the grate, and it has been discovered that the highest efficiency is not obtained until there has accumulated a 3- to 4-in. coating of those slow-burning particles all through the combustion chamber and over the bridge-wall; therefore, when one receives a carload of lignite for a test and is not familiar with the characteristic of the fuel one generally gets disappointing impressions.

The cost of lignite f.o.b. the mines set by our Fuel Administrator is $2.50 per ton for screened lump, $2.25 for screened 6-in. coal, $2 for mine-run and $1.25 for

screenings that have passed through a 2-in. screen. The screenings give the most suitable size of coal for boiler use, although they often contain a large amount of dirt. In mining our coal an undercutting machine is used, the cuttings from this machine go into the screenings and if the operator of the machine is not careful, he is liable to cut into the dirt or clay below the coal bed; this mixed with the coal makes it an unsatisfactory fuel. On the other hand, 6-in. coal is too large a lump for a steam coal; much of our lignite breaks up in slabs similar to sandstone, and such slabs lying flat on the burning coal smother the fire below them. Those familiar with burning lignite in stoves and heating furnaces will place those slabs up edgeways and pack the firepot full of it and get results. As this cannot be done under boilers, the coal must be broken or crushed to 3 in. and less to get efficiency.

In your editorial you speak of pulverizing lignite for use in the furnace. That process has been under much discussion through the columns of *Power*, and from what I learned from reading those columns there is no gain in burning a high-grade powdered coal when considering the cost of drying, pulverizing, maintaining the furnace walls and the excess air admitted to the fuel in the process of burning it. The cost to pulverize a pound of low-grade coal is practically the same as a pound of high-grade coal, and the moisture must also be disposed of before the lignite is pulverized.

Lignite will absorb moisture from the atmosphere after it has been dried; therefore, I doubt the possibility of burning it in that form. You also say that lignite in a natural state cannot be transported even short distances from the mines for the reason that the moisture evaporates, causing the substance to break up in small chunks and flakes and if subjected to much jarring it disintegrates into powder, all of which makes the fuel inconvenient to handle.

Lignite will slack to some extent when exposed to heat, but nobody here worries about that. We are now advised by our fuel administrator and governor to fill up our coal bins so the mines can be kept in full operation during the summer. We will then be able to send South Dakota and Minnesota lignite next winter.

Bismarck, N. D. C. P. LARSEN.

Different Rate of Scale Formation

In the issue of Apr. 16, page 559, Mr. Lewis suggests that scale formation is greatest on the side of the boiler nearest the soot-blowing openings because there is less soot on the tubes on that side, etc.

We have trouble here with scale forming in nine tubes out of eighteen, and these nine tubes are not always those nearest the soot-blowing openings, while in the letter by Thomas Pascoe in the issue of Apr. 9, page 521, he states that it is always the tubes next to the soot-blowing openings that scale most. We use oil fuel, have three burners in each furnace, have the dampers exactly alike and run with the stop valves for the feed water full open on all drums, but there are always nine tubes with scale (of course that is the number for each drum), and always the same ones. It is not likely that burners in certain locations always give out much more or less heat than the others; besides, changing the position of burners is a common occurrence.

Anyox, B. C., Canada. J. B. TAIT.

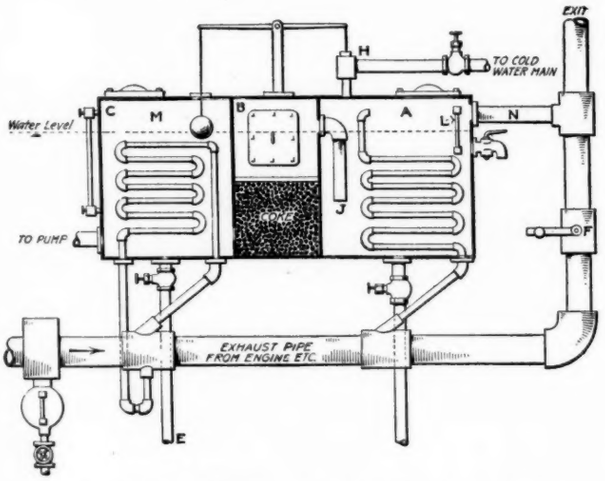
Plugged Holes in Piston

I recently had an experience with an engine that may be of interest. I first noticed a rather dull thumping in the cylinder as the piston came to the head end of the stroke. I realized that something was wrong, and at the first chance I removed the cylinder head and to my surprise found a hole in the piston about three-fourths of an inch in diameter with a crack extending on each side. I reamed out the hole and screwed in a 1¼-in. flush pipe plug and drilled a ⅛-in. hole at each end of the crack to prevent its extending further, and have had no trouble since. C. RICHARD WARD.

Willsboro, N. Y.

Feed-Water Heater and Filter

The illustration shows a heater and filter of my own design, which can be built of quarter-inch boiler plate or cast-iron plates and may be either round or square, although I prefer the latter. A live-steam connection, with a reliable pressure-reducing valve attached, supplies steam for heating the water when there is no exhaust



HOME-MADE FEED-WATER HEATER AND FILTER

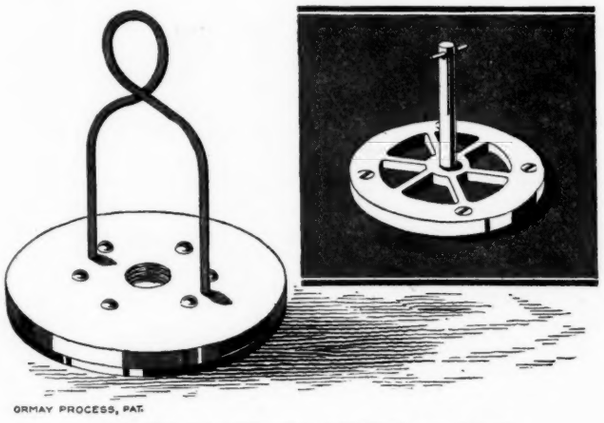
steam. Traps discharging clean condensate from live steam can be connected into part *C*, but if the condensate contains any oil it should go to compartment *A*. There are manholes in each compartment for cleaning, and drains to the sewer are provided, also an overflow *M* to the sewer, in case the makeup cold-water supply control should get out of order. The back-pressure valve *F* is set at a pressure just enough to cause steam to circulate up through the coils into the tank. In the center compartment there is a deep bed of coke, on top of which are several thicknesses of burlap bags and over these about ten inches of excelsior.

The water supply enters compartment *A*, passes up pipe *J*, down through compartment *B* and into *C* at the bottom, thence to the pump. Most of the sediment will settle in *A* and the oil will float to the top, but if any does escape it will be collected in the filter. Part *A* will require cleaning quite often, but *B* only once in about three months and *C* once in six months. Pipe *N* acts as a relief to guard against an accumulation of pressure should the valve *F* be set too heavy.

Portsmouth, Ont., Canada. JAMES E. NOBLE.

An Easily Made Draining Valve

The illustration shows a simple valve for draining tubs and tanks. The disk is cast iron with a ¼-in. cloth insertion rubber packing riveted to it, and the seat is similar to that of a pump, as shown, fastened to the bottom inside of the tank with screws counter-



OUTLET VALVE FOR BOTTOM OF TANK

sunk flush with the surface of the seat. I have made a number of 4-in. valves of this type, and they were entirely satisfactory. The sheets of soft-rubber packing make a tight joint that will give, and close around any small object that may get under the disk.

New Bedford, Mass. H. K. WILSON.

Cleaning Condenser Tubes with Muriatic Acid

Regarding cleaning condenser tubes with muriatic acid, as noted by Mr. McKeehan on page 504 in the issue of Apr. 9, we have found here, in Grand Rapids, that the method is effective, economical and not injurious to the tubes.

The city is supplied with a lime-softened water averaging about six grains of scale-forming matter per cubic centimeter and, like all lime-softened waters under certain conditions of heat and pressure, tends to deposit a small amount of carbonate of lime, which in time becomes more or less serious on the surface of condenser tubes. At the city pumping station two of the pumps are equipped with condensers containing approximately 1400 one-inch tubes about seven feet long. In a year's time these tubes become so coated over as to drop the vacuum from about 28 to 24 in., a matter serious enough to require attention.

For the last two years the method of cleaning these tubes has been to disconnect the condensers and swing them clear of the suction connections, apply blind flanges to the inlet and outlet sides and fill them up with water to which has been added a first dose of 20 to 25 gal. of muriatic acid. Steam lines are connected in and this charge is boiled two hours or so till the acid has been used up, then more water and acid added, say five to seven gallons, till the tubes are boiled clean. Usually we have found about 55 gal. of acid sufficient, and boiling greatly hastens the work; a day is usually ample time to do a good job. This method has worked equally well in cleaning the oil-cooling tubes of our turbo-generators.

For the last three years an acid cleaning method has been used in the condensers at Columbus, Ohio, where the water supply is similar to that of Grand Rapids, and the type of the condensers does not readily admit of their being removed. In this case the acid is sprayed on with a force pump, a small fan being set up behind the men manipulating the spray to carry the fumes of the acid through to the other side and away. I understand that this method also works satisfactorily.

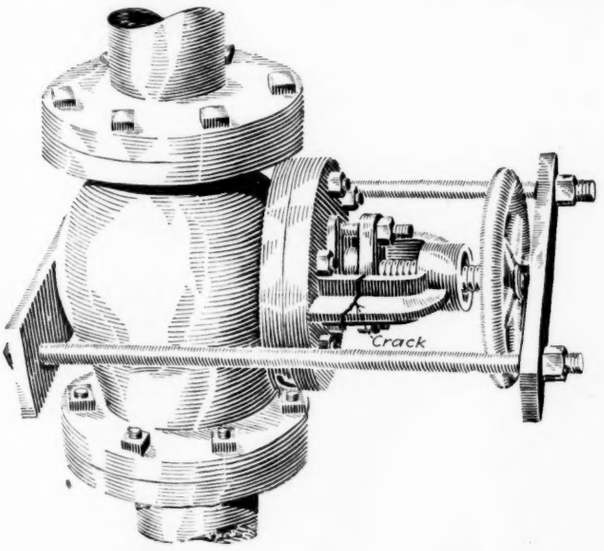
Grand Rapids, Mich. WALTER A. SPERRY.

Some Emergency Valve Repairs

In the plant where I am operating I recently had a little trouble with a 2½-in. throttle valve on a pump. The valve had broken at the yoke, due to water-hammer. As I did not care to use this pump as much as I did another one on the same line, I obtained two 2 x 4-in. pieces of iron and drilled holes through them, and placing one piece below the valve body and the other against the nut on the valve-wheel stem, the two were drawn together, and the cracked yoke back to place with the long bolts and nuts, as shown in the illustration.

A few days ago one of the pumps worked badly, becoming air-bound; when stopped, there was a continuous stream of water coming from the pump, which could not be stopped unless the glands were screwed up very tight. An examination showed that a 5-in. check valve was unseated, the bottom guide having been broken off and the top guide badly worn on one side. Not having another valve of that size in stock, I proceeded to repair the broken one as follows:

I took the top half of the valve to which the guide for the bottom is fastened, drilled a ½-in. hole through it, and then resurrected an old valve stem ½ in. diameter



CRACKED YOKE DRAWN TOGETHER

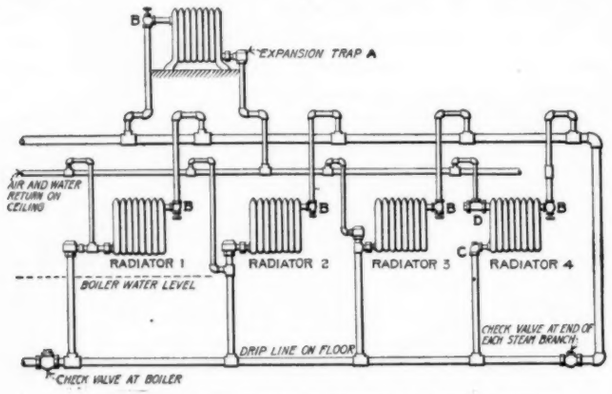
and cut it to the proper length and riveted it in the place of the one that had been broken off. The worn upper guide was cut off with a hacksaw and treated in the same manner as the lower guide. The valve was back in place in less than one-half hour, and it has worked as well as a new one ever since.

Fort Apache, Ariz. ROBERT E. LEECH.

Radiator Connections

One type of steam-heating system uses a small expansion trap on the outlet of each radiator, a return trap to put the water back into the boiler, and one air valve to let air out of the whole return system. The small traps on the radiators let air and water pass, but close against steam. The common air and water return must be above the water level of the boiler.

In one instance it was necessary to connect some wall-type radiators below this common return line, but still above the boiler-water level. They were first connected as radiator 1 shown in the illustration (the others being marked 2, 3 and 4). The air was expected to go to the air and water return and the water to go down through the radiator trap into the drain from the steam mains; but steam, blowing through these radiators and backing up to the radiators on the upper floors, shut the outlet traps and closed the air valve



RADIATOR CONNECTIONS TRIED OR SUGGESTED

at the boiler, so the air could not clear from the system and the water would not return from the radiators—the system became steam- and air-bound.

The connections were then changed as shown in the next case (radiator 2), but on the first cold day the steam pressure forced the water out of the drip line, along the floor, and caused water-hammer. Connection 3 was considered as a remedy, but as the traps do not close against water unless it is near the boiling point, this plan was discarded and connection 4 adopted. As steam is lighter than air, it passes across the top of the radiator and closes the air valve while the lower half of the radiator is cold, but by letting the air valve blow a little steam, the radiator gradually clears of air and the small blow of steam does not interfere with the rest of the system. Discussion and any suggestions for improvement will be welcome.

Washington, D. C. MORRIS ELLISON.

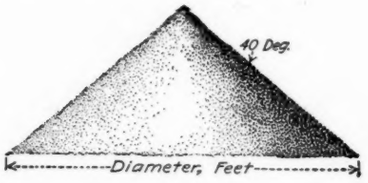
Weight of Ashes in Conical Pile

The angle of repose for ashes in a conical pile, that is, the angle made by the sloping side of the cone with the horizontal, as shown in the accompanying illustration, averages 40 deg. The average weight of ashes per cubic foot is 40 lb. Based on these two figures, it follows that a formula can be developed suitable for determining the weight of any conical pile of ashes. All that is necessary is to measure the diameter of the base. The formula is as follows:

$W = 4.4\ d^3$ = weight of conical pile of ashes in pounds.

where d is the diameter of base pile in feet.

To illustrate: The diameter of a pile of ashes is 8 ft. Then $8^3 = (8 \times 8 \times 8) \times 4.4 = 2253$ lb. of ashes



AVERAGE ANGLE OF CONICAL ASH PILE

in a conical pile having a diameter at the base of 8 ft. The accompanying table gives the weight of ashes in

WEIGHT OF ASHES IN CONICAL PILE

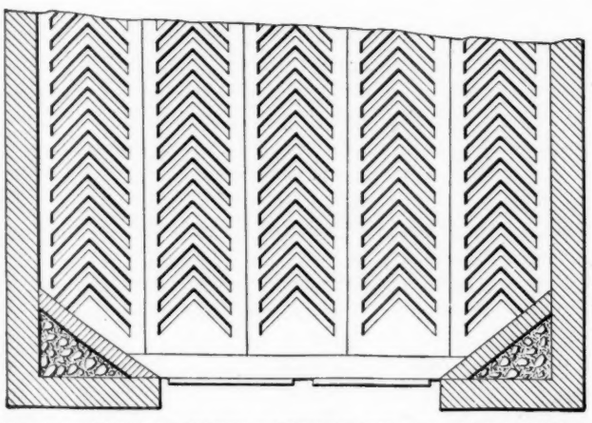
Diameter of Ash Pile, Feet	Weight of Ashes, Pounds	Diameter of Ash Pile, Feet	Weight of Ashes, Pounds
1	4.4	10	4,400
2	35	15	14,850
3	119	20	35,200
4	282	25	68,750
5	550	30	118,800
5.5	730	35	188,650
6	950	40	281,600
6.5	1,210	45	400,950
7	1,509	50	550,000
7.5	1,857	60	950,400
8	2,253	70	1,509,200
8.5	2,702	80	2,252,800
9	3,208	90	3,207,600
9.5	3,771	100	4,400,000

conical piles from 1 up to 100 ft. in diameter, and any intermediate diameter of ash piles not shown in the table can be easily computed. W. F. SCHAPHORST.

New York City.

Boiler Firebox Improved

The illustration shows a top view of an improvement in the shape of the furnace under a return-tube boiler fitted with stationary grates. The bricks on the side wall and front were chipped out, and others were placed so as to cut off or fill in the sharp corners of the box, at the same time cutting off but little of the space. The object is to make it possible to clean the fire more



BETTER RESULTS WITH CORNERS FILLED IN AS SHOWN

quickly and to avoid the loss if these corners are neglected when cleaning or left uncovered when firing. The space behind the bricks was filled with pieces of brick and fireclay, and the top was sloped so that no coal or ashes can gather there.

Flushing, N. Y. WILLIAM F. WILLIAMSON.

Inquiries of General Interest

Melting Point of Firebrick—What temperature will injure boiler-furnace firebrick? B. H.

When firebrick contains moisture or materials that have a higher coefficient of expansion than the binding material, the brick spawls and cracks with comparatively low temperatures. The melting point of ordinary commercial fireclay brick ranges from about 2700 deg. F. to 3200 deg. F., depending on the ingredients.

Pressure of Atmosphere from Height of Barometer—How may the pressure of the atmosphere be known in pounds per square inch from the height of the barometer? W. G.

At ordinary atmospheric temperatures the weight of a cubic inch of mercury may be taken as 0.491 lb. and the pressure of the atmosphere in pounds per square inch may be found by multiplying the height of the barometer in inches by 0.491.

Heat Required To Raise Temperature of Air—How many B.t.u. per hour would be required to heat 55 cu.ft. of air per min. from 62 to 300 deg. F.? J. C. E.

At 62 deg. F. there are 13.14 cu.ft. of air per pound. The specific heat of air is about 0.25, and to raise the temperature of a cubic foot from 62 deg. F. to 300 deg. F. would require $(300 - 62)\ 0.25 \div 13.14 = 4.52$ B.t.u., and for heating 55 cu.ft. per minute would require $4.52 \times 55 \times 60 =$ 14,916 B.t.u. per hour.

Adding Heat to Constant Volume of Steam—If heat is added to steam in a closed vessel, would the temperature as well as the pressure rise? C. T. B.

The addition of heat would cause a rise of both temperature and pressure. The addition of sufficient heat would first convert any water present into dry saturated steam which would be of higher temperature and pressure than the original steam, and further addition of heat would still further raise its temperature and pressure to a superheated condition.

Iron Ball Pyrometer—How is the temperature of a boiler furnace obtained by heating a piece of cast iron in the furnace and afterward cooling it in water? G. R.

A piece of cast iron weighing 4 or 5 lb. and preferably of spherical or other compact form is allowed to remain in the furnace until it has attained the temperature of its surroundings. It is then suddenly plunged in a vessel containing a known weight and temperature of water and cooled while the water is being stirred rapidly until the piece of cast iron and the water attain the same temperature. The vessel may consist of a large bucket filled about three-fourths full of water and provided with a cover having a hole in it through which a perforated pipe extends to the bottom for the insertion of a thermometer. The hole in the cover may be large enough to use the pipe for stirring the water. If W = the weight of water, w = the weight of cast iron, t the original and T the final temperature of the water and S the specific heat of the cast iron, then the temperature of the piece of iron when placed in the water is found by the formula,

$$x = \frac{W(T - t)}{wS} + T$$

For example, if the weight of the piece of cast iron is 5 lb., the weight of the water 20 lb., the temperature of the water before the immersion 60 deg. F and after immersion 120 deg. F., and allowing the specific heat of cast iron at the furnace temperature to be 0.13, by substituting,

$$x = \frac{20(120 - 60)}{5 \times 0.13} + 120 = 1966\ deg.\ F.$$

Oil for Journal Bearings of Steam Dry Cans—In the textile-finishing business a machine is used that has steam-heated revolving cylinders called dry cans for which the steam used is conducted through the hollow journals on which the cans run. The bearings often attain a high temperature, and difficulty is experienced in keeping the bearings properly lubricated. What kind of oil would be suitable? O. M. W.

Most refiners of mineral oils are prepared to furnish lubricating oils suitable for use at ordinary temperatures of steam and, when informed of the pressure of steam supplied to the dry cans as an index of the temperature, would be enabled to select a product adapted to the conditions.

Testing Boiler-Feed Pump—How can a boiler-feed pump be tested to show that it is in fair working order? S. L. A.

Connect a steam-pressure gage to the steam-chest cover and a water-pressure gage with stop-cock on the delivery side of the pump. Then with a steam-chest pressure of about 50 lb. it should be possible to obtain a full bore of the delivery pipe when delivering against an equal water pressure. The pressure on the water-end gage is obtained by regulating the stop valve, and the discharge of water should be visible, and with equal steam and water pressure the water pressure gage should be reasonably steady. If the delivery of water stops while the pump is running, the fault will be due to leaky suction valves or piston slippage. Violent pulsations of the water-pressure gage usually will be an indication of leaky suction valves. When running slowly, if a piston travels suddenly to the end of the cylinder, the suction valve on that end will probably be the one that leaks most.

Determining Cylinder-Clearance Volume—How is the cylinder-clearance volume of an engine determined? H. N.

The cylinder-clearance volume is determined from the volume of water that can be contained by the clearance space when filled from the piston at the end of the stroke back to the valve seats. An opening needs to be provided at the top of each end of the cylinder for introducing the measuring water, or it may be introduced by the indicator connections provided suitable provision is made for the escape of air from the cylinder during the process of filling the cylinder with the measuring water. Place the engine on dead-center at the head end of the cylinder, and after removing the valves, cover each valve seat with a rubber gasket held down tight by a block of wood wedged or bolted in place. Remove the cylinder head and pack candlewicking around the piston to prevent excessive leakage of water past the piston.

Provide two vessels each filled with clean water and take the weight of each. With the cylinder head in place, the clearance space of the head end is to be filled from one vessel and a note made of the time required. As soon as the space is filled, the first vessel is to be set to one side for subsequently determining the weight of water thus used, and the clearance space is to be kept filled against leakage for five minutes by adding water from the second vessel. The vessels are then again weighed and the weight of water used from each determined.

The average rate of leakage while filling the space may be assumed to be one-half of the rate during the filling. If

W = Weight of water in pounds used to fill the clearance space,

t = Number of minutes required to fill the clearance space, and

w = The weight of water in pounds per minute necessary to keep the space filled against leakage,

then the leakage during filling is approximately $(W \times t) \div 2$, and the clearance space will contain $W - [(w \times t) \div 2]$ lb. of water and this multiplied by 0.036 will give the space in cubic inches. The clearance for the crank end of the cylinder is found in the same general manner.

[Correspondents sending us inquiries should sign their communications with full names and addresses.—Editor.]

The Storage of Bituminous Coal*

By H. H. STOEK†

An unusually valuable paper on why coal should be stored; the practicability of storage and effect of storing on the coal; systems of storage employed; cost per ton, and precautions to be observed.

ALTHOUGH the storage of coal has become of unusual importance under war conditions, it should not be considered only as a war expedient, and plans for storage should be made by every householder and in connection with every industry that uses coal as one of the adjustments necessary to stabilize a fundamental industry of the country.

The demand for coal varies with the weather conditions and is largely a seasonal one, not only as regards domestic fuel, but in connection with fuel used for power purposes. As a result of the unequal requirements at different seasons of the year, and the failure to store coal during periods when small amounts are used, the mines of the United States operate only about 200 days per year and the demands upon the railroads for handling coal are unequally distributed, the greatest demand coming during the fall when railway equipment is needed for handling crops and during the winter months when operating expenses are greatest.

As a result of the reduced time of working of the mines, an extra daily wage must be paid the miner and other employees if they are to make a yearly living wage, and there must be also an excessive number of mines to take care of this peak load during a part of the year.

A reason often advanced against storage is the increased cost involved, but a suitable readjustment of mining and transportation conditions should mean a lower cost for mining and transportation that would, at least partly, offset the additional necessary cost for storage and should not increase the cost to the consumer much, if any.

Storage Should Add but Little to Cost to Consumer

The effect of storage upon coal may be considered under the heads of appearance, loss in heat value, difference in firing qualities of stored coal, change in coking properties, change in gas-making properties, and degradation, or the increase in the amount of fine coal and dust due to breakage from handling and the slacking or weathering due to exposure to the air.

With reference to appearance the exterior of a pile of certain kinds of coal frequently becomes covered with a white coating of sulphate of iron or it may be rusty and dirty in appearance. Usually, this change in appearance is only "skin-deep," and the interior is not changed in appearance to any extent, excepting with certain slack coals. Some coals have a much dirtier appearance in the piles after being in storage, and although the heating value is not reduced thereby the sale value may be decreased because, to the domestic user particularly, the appearance of the coal means much.

Loss in heat value, due to storage, is much less than is commonly thought. It varies with different coals and is greater for screenings than for screened coal. Experiments by Prof. S. W. Parr, University of Illinois, show a loss of only 3 to 3½ per cent. for screenings and also that coals vary in this respect. Those from southern Illinois show less change than those from central Illinois; also coals that show a small decrease at first continue to have only a small decrease as time goes on.

There is a general and widespread opinion that stored coal is dead when put on the fire and is often considered and condemned as being "no good." Although there is no great decrease in calorific power, it is quite probable that, due to the oxidation of the surfaces of the lumps of coal, they burn less freely, but experiments made at the University of Illinois on a stationary boiler showed that the stored coals tested had an equal evaporating power with the fresh coal, provided a thinner bed was carried and greater draft furnished.

Spontaneous Ignition of Stored Coal

The greatest objection to storing coal is the liability to spontaneous combustion, which is due mainly to the oxidation of the carbon and other organic materials in the coal and to a less extent to the oxidation of the sulphur in the iron pyrites contained in most coals. Freshly mined coal has a tendency to oxidize and heat, and while this property varies with different coals, the general rule apparently holds for all coals. The finer the coal the greater the surface exposed to the air and the greater the tendency to oxidation and heating. Lump coal is not so likely to fire as fine coal, slack or run-of-mine. Any method of storage must either prevent or check the absorption of oxygen to such an extent that the generation of heat may not proceed so rapidly as to exceed the heat lost by radiation. The greater the time between mining and storing the less the liability to firing.

High-volatile matter does not increase the liability to spontaneous combustion, according to the experiments of Porter and Ovitz, of the Bureau of Mines. The high-volatile coals in the West are liable to spontaneous combustion, but Porter and Ovitz conclude that this is due more to the nature of the volatile than to its amount. Sulphur in coal assists in spontaneous combustion by oxidizing and breaking it up so as to produce greater fines, and also in its oxidation, heat is produced. In selecting a coal for storage a low-sulphur coal is to be preferred.

The effect of moisture on spontaneous combustion is an unsettled question, but it is undoubtedly safer practice not to wet coal for storage; if it can be avoided, do not store a layer of dry coal on a wet layer. The effect of water in helping to disintegrate high-sulphur coals is undisputed.

Data on the effect of storage on the coking properties of coal are scarce, but the general opinion is that unless the coal heats and thus changes in character, its coking properties are not materially influenced. According to the experiments of White, the gas-making qualities of Eastern coals are not decreased by storage.

There is often thought to be a loss in weight of stored coal, but this is more apparent than real and may be due to the evaporation of moisture.

Nearly All Coals Can Be Stored if Properly Piled

There is an erroneous, misleading but widespread opinion that the locality from which the coal comes determines whether or not it can be stored. One frequently hears such remarks as "Eastern coals" (meaning those from Pennsylvania and West Virginia) can be easily stored, but Western coals (meaning those from Illinois and Indiana) cannot be and they are much more liable to spontaneous combustion." Both parts of this statement are too broad, for scientific research and experience have shown that nearly any coal can be stored if it is properly piled and nearly any coal improperly stored will heat and may fire.

Coal should be stored preferably during the spring and summer so as to help the railroad and mining situations; labor costs are usually less. The disadvantage of summer storage is that the coal maintains this temperature for a long time.

The size, shape and depth of piles depend mainly upon the appliances used for storing. There is a great difference of opinion as to the height to which coal can be safely piled and stored. Many would limit the pile to 10 ft. in height,

*Abstract of paper read before the Western Society of Engineers, Chicago, April 15, 1918.

†Professor of Mining Engineering, University of Illinois.

although many dock piles are 50 to 60 ft. high, and the chief objection to high piles is the difficulty in handling and moving the coal quickly in case the temperature rises and also the difficulty of testing for an increase in temperature. The idea that firing takes place at the bottom of the pile due to the pressure and crushing on account of the height is not borne out by the facts, as many fires seem to start near the top as near the bottom and near the outside as the inside of a pile. Since the weight of a cubic foot of broken coal is about 40 lb., a column 50 ft. high weighs only 2000 lb., which gives a weight of only about 14 lb. per sq. in. at the bottom of the pile. This is small compared with the crushing strength of most coal even when it is considered that the coal does not rest on a solid base, but is supported in many cases on the points of the pieces of coal. Heating due to pressure is certainly overestimated, probably also pressure due to the weight of the overlying coal.

It is generally accepted that if the air supply is shut off from the coal, as is the case with under-water storage, spontaneous combustion cannot occur, and also it is reasonable to assume that if ample ventilation can be furnished to carry off the heat and keep down the temperature in a coal pile, spontaneous combustion will not occur. It is the intermediate condition that is dangerous. On the other hand, run-of-mine coal often cannot be safely stored, because not only is there then present an excessive amount of fine coal that will oxidize readily, but the openings between the lumps contain considerable fine coal, which shuts off a free circulation of air.

This also explains why alternate stratification of coarse and fine coal is undesirable and why air passages due to large lumps rolling to the bottom of the pile should be avoided, because they form a duct or chimney for an amount of air to reach the fine material inside the pile, sufficient to promote oxidation but insufficient to keep down the temperature.

Ventilating a Coal Pile

The practicability of properly ventilating a coal pile has been disputed, and while the consensus of opinion in the United States is against ventilation by pipes, it is probable that many of the opinions expressed are based upon unfavorable results secured through improperly installed and inadequate ventilation schemes. Many of the so-called pipe ventilation schemes have been little more than the occasional placing of a pipe into which a thermometer can be inserted to read temperatures. There are few records in the United States of a systematic and adequate ventilation scheme being installed, because such a scheme is expensive and it also undoubtedly interferes with the rapid handling of the coal. It is contended by many that closely packed coal is so poor a conductor of heat, fire can start very close to a ventilating pipe.

Several instances of successful ventilation have been cited to the writer in connection with railroad work in the United States and Canada. Dr. J. B. Porter, of McGill University, is convinced that the method of ventilation used by the Canadian Pacific R.R. and others in Canada is efficient and entirely practicable. It is questionable whether the cooler climate of Canada has anything to do with the effective ventilation noted by Dr. Porter. Data upon this subject for Illinois conditions are certainly not yet conclusive, and ventilation is a questionable experiment.

The common methods for testing heating coal piles are: Watching when the pile begins to steam, the odor which is either that of burning bituminous matter or burning sulphur; by means of an iron rod inserted into the pile and when drawn out tested by feeling with the hand; by means of the thermometer inserted into a pipe driven into the pile; and by spots of melted snow.

Opinions differ widely in regard to when the temperature reaches a critical or danger point. Parr says, "Bituminous coal can be stocked without appreciable loss of heat value provided the temperature is not allowed to rise above 180 deg. F." How close to this temperature a pile should be allowed to heat is largely a matter of judgment, for if the rise seems to be decreasing rather rapidly, it may be safe to allow it to approach the 180-deg. point; but if it is steady and regular, it is wise to load out the pile before the danger point is reached. This rise also depends upon the means available for loading out, for at a point equipped with large grab buckets and means for rapidly handling the coal, a higher temperature can be permitted than when considerable time may be required to load out the coal. A person in charge of a certain kind of coal under certain climate conditions will soon learn what is the danger point, and it is impossible to set any critical temperature that will apply to all coals under varying storage conditions. The only safe rule is to watch the temperature closely and get ready to load out when the temperature reaches 150 deg. and to move the coal if the temperature reaches 175 degrees.

Water Not Effective in Putting Out Fires

Water generally has not proved effective in putting out fires, probably because it cannot be applied or is not applied in sufficient quantities to thoroughly cool the entire mass. It is the general opinion that except for quite small piles which can be completely soaked, water will aggravate rather than put out a fire. Water frequently cannot reach the fire because of a layer of coke that has formed a protection about it. One large pile in Chicago was soaked as completely as possible with streams from river fire tugs, and while the fire was apparently out, within two or three days it was burning as fiercely as ever. If the coal can be spread out thinly and thoroughly saturated with water, the fire can be put out, but very often there is not sufficient ground available to permit proper spreading, for which reason most of the efforts to use water have been unsuccessful.

Inert gases, such as carbon dioxide, have been tried, but no successful results have been reported, because with an outdoor pile it is impossible to confine such gases, and even with inclosed piles where this has been tried, the same difficulty has been met with.

The author enumerated the points to be considered in the choice of a storage system and the requirements of an ideal plant. Following, brief descriptions were given of the principal methods of storing, such as hand storage, storage by means of a motor truck, trestle storage, storage with side-dump cars, side-hill storage, mast-and-gaff storage, locomotive-crane storage, circular storage, steeple storage, bridge storage and under-water storage. For more complete details reference was made to the speaker's paper on "Storage of Coal," Circular No. 6, Engineering Experiment Station, University of Illinois, Urbana.

Locomotive Crane Storage

Under the heading of "Locomotive Crane Storage," reference was made to the practice of the Commonwealth Edison Co., of Chicago, and the following conclusions by W. L. Abbott based upon storage of all varieties of Illinois coal over long periods:

"Nearly any coal that has gone over a 1½-in. screen can be stored. Coal of any size with duff left in it will heat.

"Pea coal (over ½-in. through ¾-in.) has been in storage for more than a year without heating. Coal with screenings removed has been kept in storage eight years without firing."

The coal is stored on the ground in continuous pyramidal piles 25 ft. high, each pile being between two pairs of railroad tracks.

Cost figures for storage and reclaiming from a number of different companies were presented. Some of the figures given include only labor and supplies, with no allowances for overhead, insurance, rental for the land, depreciation and interest on the investment. For hand storage the cost per ton varied from 15 to 64 cents; with the locomotive crane, from 5 to 50 cents; with the steam shovel, 20 cents; with bridge storage, 11 to 60 cents; and with under-water storage, 9 to 22.5 cents.

As the result of a rather detailed study of a number of storage plants and as a digest of the opinions expressed in answer to a questionnaire sent to a large number of those who have had extended experience in storing coal, the following have been decided upon as conclusions that are justified by present storage practice:

It is practicable, advisable and advantageous to store bituminous coal not only during war times, but also under

normal conditions either at the mines, near the point where it is to be used, or at some intermediate point. It is well to store coal as near the point of consumption as possible to avoid rehandling.

The danger from spontaneous combustion is due more to improper piling of coal than it is to the kind of coal stored. Most varieties of bituminous coal can be stored in the air if of proper size and if free from fine coal and dust. The coal must be so handled that dust and small coal are not produced in excessive amounts during the storing, because spontaneous combustion is due mainly to the oxidation of the coal surface.

All varieties of bituminous coal can be stored under water, which excludes the air and prevents spontaneous combustion.

The danger of spontaneous combustion in storing the coal is greatly reduced if not entirely eliminated by storing only lump coal from which the dust and fine coal have been removed. Of two coals the less friable should be chosen for storage.

Spontaneous combustion may be guarded against by preventing air currents through the pile by means of a closely sealed wall built around the pile, and by closely packing the fine coal. Such a coal pile must be closely watched for heating. The only absolutely safe way to store slack or fine coal is under water.

Fine coal or slack has sometimes been successfully stored. Many varieties of mine-run coal cannot be stored safely because of fine coal and dust mixed with the lumps.

Coal exposed to the air for some time may become "seasoned" and thus may be less liable to spontaneous combustion, due to the oxidation of the surface of the lumps of coal, but opinions upon this point are not unanimous.

It is believed by many that damp coal stored on a damp base is peculiarly liable to spontaneous combustion, but the evidence is not conclusive.

Air Should Circulate Freely Through the Coal

To prevent spontaneous combustion coal should be so piled that air can circulate through it freely and thus carry off the heat due to oxidation of the carbon, or else it should be so closely piled that air cannot enter the pile and oxidize the fine coal.

Stratification or segregation of fine and lump coal should be avoided since an open stratum or a chimney of coarse lumps of coal gives a passage for air to enter and come in contact with fine coal and thus to oxidize it and start combustion.

If space permits, low piles are preferable.

Coal of different varieties should not be mixed in storage if this can be helped, for one coal more susceptible to spontaneous combustion than the other may jeopardize the safety of the pile.

The heating value of a coal is decreased little by storage, but the belief is widespread that storage coal burns less freely when fired in a furnace. Experiments indicate that much of this can be overcome by keeping a thinner bed on the grate than is kept with fresh coal and by regulating the draft.

Pieces of wood, greasy waste or other easily combustible material mixed in a coal pile may form a starting point for a fire, and every effort should be made to keep such material from the coal as it is being put in storage.

J. L. Hecht, mechanical engineer of the Public Service Co. of Northern Illinois, never had a fire in a storage pile of lump coal; that is, coal that had been screened. No attention had been paid to the height of the pile except from the standpoint of convenience of handling. The company never stored screenings, but had stored No. 3 nut coal for three or four years without signs of heating.

Screenings had been stored successfully at the University of Illinois by packing the fuel closely and excluding the air as much as possible. Coal from a truck was dumped on a former tennis court, which offered a hard foundation. When the fuel reached a certain height, it was smoothed over and pressed down into a compact mass by means of rollers. Plank roads were then laid on the pile so that the truck could distribute another layer of coal and this in turn was rolled down as before. To prevent air circulation from the sides, a board fence surrounded the pile. Heating developed in a couple of places where other coal had been mixed with the screenings, but otherwise this method was satisfactory. The cost for storing and reclaiming had averaged about 40c. per ton.

James Macdonald, president of the Macdonald Engineering Co., had developed, for a plant in Michigan, a vertical method of storage, which appeared to possess advantages over the various horizontal plans universally used. He was a firm believer in the exclusion of air and this was effected in the present case by storing the coal in two vertical reinforced-concrete tanks resembling the farm "silo." The tanks were 28 ft. diameter by 70 ft. deep. Depending upon the foundation, it was easy to vary the dimensions to suit the requirements. The storage was fireproof, occupied little space and was convenient to the power house. Slack coal had been stored so successfully that a duplicate installation was now being made. In case of heating, conveyors had been provided so that the bottom coal could be removed and transferred to the top and water pipes had been laid so that the tanks could be flooded. Neither of these precautions had to be used as the coal never fired.

Weights and Measures in Venezuela

The use of the metric system in all business transactions is not only legal but compulsory throughout Venezuela. The law of Feb. 13, 1857, prescribed that, beginning Jan. 1, 1858, the metric system should be used in all the government offices and for all public acts, and that a year later it should be used by all Venezuelans. Evidently the last-named proviso was not enforced for the old system of weights and measures continued in almost universal use among the people until the issuance of the decree of May 18, 1912, which was based on the old law and took rigorous steps to put it into effect. Under date of Feb. 13, 1914, the Federal Executive prescribed rules for the use and practice of the metric system. A pamphlet was published in Caracas in 1916 under government auspices and shows in detail the steps that have been taken to make the use of the metric system compulsory and to uproot the old methods which had survived.

The strict measures taken have compelled the adoption of the metric system for all business transactions of any importance. Not only is it illegal to use any other weights and measures, but a merchant is subject to punishment even for having them in his possession. The use of units indicating another system in addition to the metric is also illegal. The importation of weights and measures other than the legal is prohibited, and as the authorities have destroyed the old ones wherever possible, distinct progress toward the universal adoption of the new system has been made.

In spite of the stringency of the laws, the people at large, especially in the country, still cling to old units in their everyday life and talk and think in terms of them. This will only be finally remedied by the growing up of a new generation.

The units of weight and measurement formerly in use in Venezuela were varied as well as variable. Many of the measures differed according to the article and the locality. Thus the fanega, which was widely used, and for much the same purposes as in the bushel in the United States today, weighed from 110 to 864 lb., depending on the product measured and the locality concerned. The quintal of 100 Spanish pounds, equivalent to 101.4 English pounds, was formerly much employed in the sale of coffee, cocoa and other products; and this usage still survives, although the transactions are officially reported as "per 46 kilos," which is the equivalent of the quintal.

It is generally agreed here that the compulsory adoption of the metric system was a wise measure and that its use has simplified and facilitated the transaction of business.—*Commerce Reports.*

A little more care in cutting out gaskets from sheet packing will make a big saving in that commodity. It is time that more attention was paid to this important, if minor, detail.—*Marine Engineering.*

National Coal Conference

Under the auspices of the United States Railroad Administration and the United States Fuel Administration the International Railway Fuel Association held its tenth annual convention in Chicago on May 23 and 24. Hotel Sherman was headquarters for the convention, and the meetings were held at Cohen's Grand Opera House. Upward of 1500 attended, including mine operators, representatives of the mine workers, railway executives and employees, railroad and fuel administration representatives and heads of industries that make large demands on fuel and transportation. It was an enthusiastic meeting, held with a view of bettering the coal situation, to impress on each factor the necessity for maximum efforts and the need for coöperation. Those attending were pledged to carry home the spirit of the meeting and inspire the vast army of workers responsible for results. Nearly a million copies of the proceedings will be distributed to these men.

Expressing the sentiments of those addressing the convention, American miners must get out more and cleaner coal. American railroad men must furnish the locomotives and the cars to haul it, and in their use of fuel must make every pound count. The consumer can also do his part by ordering now to relieve the situation later on. It was made apparent that there was no lack of miners and that if they were employed full time as in other trades, there would be no coal deficiency.

In his opening address E. W. Pratt, president of the Association, summed up the railroad coal problem as one of hauling more coal with fewer cars. It was a question of doing the maximum amount of work with the facilities at hand. Regional Director Aishton, of the United States Railroad Administration, declared that the only thing that mattered for all of us now is the maintenance of that line "over there." He begged the miners and railway men of America to "strip to the waist" and do their utmost to help maintain that line. Trooper Scott, of the Anzacs, told how he pleaded with the coal miners to supply the fuel to win the war, and how when they realize what their work means, they go to it harder than ever to increase the output. His plea to the miners was, "Load all the coal you can and load it clean."

Thomas Britt, general fuel agent of the Canadian Pacific Ry., spoke for Canada, emphasizing the importance of coal loaded clean and free from slate, dirt or other nonburning substances. Troopships burning dirty coal are slowed down in the U-boat zone, doubling the danger of the thousands of soldiers carried to the front.

R. Quayle, general superintendent of motive power and car department of the Chicago & Northwestern Ry., urged that every man make it a personal matter to cut out waste of coal in railway operation. In a paper prepared by W. S. Carter, labor director of the United States Railroad Administration, and read by Eugene McAuliffe, it was stated that in the spring of 1919 American railroads must be ready to haul cargo and bunker coal for 8,000,000 tons of army shipping, supplying 2,000,000 American troops in France. This, in addition to the present great fuel demand, would necessitate that the eight-hour work day, desirable in peace, yield to the Nation's need, and that railway men must prepare to work as many hours as the job may call for up to the limit of their power. Better maintenance of locomotives as a means of saving coal was urged by Frank McManamy, director of the locomotive maintenance division of the United States Railroad Administration. It was estimated that defective and neglected motive power would cost the American railways this year $50,000,000 worth of coal, besides the great loss of efficiency.

On Thursday evening the feature was a motion picture dealing with the conservation of railway fuel. The picture had been prepared by and under the direction of the United States Fuel and Railroad Administrations and was viewed with a great deal of interest by those in attendance.

At the opening session Friday, P. B. Noyes, director conservation division, United States Fuel Administration, said that it was impossible for the railways, with their burden of war traffic, to haul the 200,000,000 tons of coal in excess of the requirements of 1914, that will be needed this year. Coal users must save the situation by saving coal, or the country would suffer a disastrous stoppage of industries. The Fuel Administration would try to keep the non-war industries supplied with coal, because these are the vital industries of peace, and their serious interruption would cause a nation-wide commercial panic. At least $20,000,000,000 of capital is invested in legitimate manufacturing enterprises not strictly needed for the war. Ten million men support their families from the work they do in these factories. Cutting off their fuel supplies would mean bankruptcy on a scale that would precipitate the greatest panic ever seen in the United States, and the sudden and forcible unemployment of at least 5,000,000 men. All responsible agents of the Government now realize that keeping labor reasonably employed and only taking it away from non-war work as fast as it can be employed on war work is nearly as important for success in this war as the manufacture of munitions and ships.

Peace in American coal fields for the duration of the war was pledged for miners and operators by John P. White, former president of the United Mine Workers of America, and now labor advisor for the United States Fuel Administration. He declared that 700,000 American coal miners were eager to work every day, Sundays and holidays, getting out the extra 200,000,000 tons of coal needed this year. It was a question of the railways furnishing the cars and the consumers placing their orders so that consecutive employment in the mines would be possible. Mr. White said that the 87,000 miners of Illinois alone, who work on the average only 160 days per year and mine 60,000,000 tons of coal, could get out 150,000,000 tons of coal this year if enabled to work full time. If the railroads would quit haggling over price and start buying their coal, everybody else would follow suit, production would rise and there would be no coal famine next winter. The one big mistake that had been made was in talking price instead of production.

H. N. Taylor, of Kansas City, a big coal operator, won hearty applause when he agreed with Mr. White that if the country had a coal shortage next winter, it would not be due to a wage war in the coal field. The mine operators have been hampered by loss of men and the wearing out of machinery which could not be replaced or repaired. They have to make the best efforts they can with what they have. The consumer has not wakened up to his responsibilities. Most of the coal mines in the Central West and the Southwest are working only half time, because the large buyers are holding back for a lower price. There is need of cooperation and coördination among the operators, the miners, the railway men and the consumers. Last year there was a shortage of 50,000,000 tons of bituminous coal. Even to keep even with last year, this much extra coal must be mined. The operators could produce it if the necessary cars were available. There are two ways of increasing the coal output: One is to produce more coal and the other to save coal. If maximum results are obtained from both there will be no coal shortage.

Eugene McAuliffe, manager of the fuel-conservation section of the United States Fuel Administration, intimated that the Government might find it necessary to take over the coal mines for the period of the war. According to Claxton E. Allen, deputy fuel administrator for Illinois, records of all coal sales are being kept, so that if necessary the administrator can take coal from those who have a surplus and allot it to others who have none.

"Fuel Oil and the War" was discussed in a paper sent by M. L. Requa, director of the oil division of the Fuel Administration. Diversion of all tankers from coastline to transatlantic army-supply service required the railways to haul an extra 100,000 bbl. of oil a day from Southwestern fields to the north Atlantic war industrial centers. Pipe-line deliveries are to be increased by 20,000 bbl. daily and the maximum number of tank cars have been placed in service. Fuel-oil users are urged to increase their storage capacity and lay in as much of their winter supply as possible before the summer is over.

The convention closed Friday afternoon with a business session at the Hotel Sherman, at which the following officers were elected: President, L. R. Pyle; vice presidents, C.

M. Butler, H. B. MacFarland and J. B. Hurley; members of executive committee for two years, B. Pemberton Phillippe, A. N. Willsie, T. Duff Smith and R. R. Hibben; members of executive committee for one year, H. B. Brown, L. J. Joffray and H. Woods.

Joint Meeting of the Chicago Section A. S. M. E. and W. S. E.

Officially, the last meeting of the season for the Chicago Section of the A. S. M. E. was held Friday evening, May 24. It was a joint dinner meeting with the Western Society of Engineers, held at the Hotel La Salle. Notwithstanding, another joint meeting will be held on June 17 at the rooms of the Western Society, the topics being "Modern Condensers" and "The Benefits To Be Obtained in the Power Plant from High-Pressure and High-Temperature Steam."

Preliminary to the paper of the evening, the question of training women for drafting work was brought up and resulted in arrangements for a meeting between educational sources and business men to see if such help was needed in this section and the possibility of introducing suitable courses. It developed that Armour Institute had already established a short intensive course to train women for drafting work.

Calvin W. Rice, national secretary, was a welcome visitor. His presence was explained as a continuation of the plan for the national officers to visit the local sections to relieve the impression that the organization is local to New York and not national in its interests. Mr. Rice had made an extended trip and had been impressed with the advance in thought among engineers. He had been particularly impressed by the motto of the new Engineers' Club at Dayton, Ohio. The speaker wanted to see coöperation between national and local bodies and between the various societies. Each engineer should do something altruistic and make the profession an instrument for the common good. He wanted to see engineers identified with the Board of Trade or similar bodies. They must be good citizens and help guide civic matters, but as a body should not take sides in politics. At the present all meeting topics should relate in some way to the war, so that in its winning, the services of the engineering societies would be preëminent.

In his retiring address President Bailey expressed the opinion that the best thing the executive committee of the section had arranged for during the past year was the joint meetings. They had proved a decided success and should be continued. The new officers elected were: Chairman, G. E. Lord; vice chairman, P. A. Poppenhusen; secretary, A. L. Rice; member of executive committee, J. J. Merrill.

John Ericson, city engineer, reviewed the construction of the Wilson Avenue tunnel and the Mayfair pumping station. The tunnel, which is eight miles long from the crib in the Lake to Mayfair pumping station, has been completed successfully and at a big saving by day labor. The finer sections of the stone removed from the tunnel were used in the concrete lining it. By the use of special screening and conveying machinery, the concrete was mixed in the tunnel, and it had not been necessary to follow the usual procedure of removing the stone from the tunnel and then taking it back again for the concrete. Excavation and lining were carried on simultaneously.

The design and erection of the intake crib, specially designed by the city, were discussed and the equipment of the station outlined. It was laid out for seven units, but only five have been contracted for. Three were designed for a head of 140 ft. and two for a head of 200 ft. The capacity of each of the former units is 25 million gallons and of the latter 17.5 million gallons per 24 hours. The pumping engines are of the Reidler triple-expansion type employed at the Lakeview Station. Six boilers equipped with underfeed stokers have been provided. The operating pressure is to be 190 lb. gage and the superheat 200 deg. Complete coal- and ash-handling facilities are being installed. It is the tenth large pumping station built for the City of Chicago. The estimated cost is $1,570,000, and that of the tunnel $3,856,000, so that the total cost of the system will approximate $5,426,000.

Price of Bituminous Coal Reduced

For a long time there has been a difference of opinion between the Fuel Administration and the Railroad Administration as to the price of coal to the railroads. By agreements with certain mines the railroads had been obtaining their coal at prices much lower than those to other consumers. The dispute has been settled conclusively by an order of the President, effective on May 25, 1918, by which the price of bituminous coal is reduced 10c. a ton and the railroads are forced to pay the Government price. The text of the order is as follows:

The United States Fuel Administration, acting under authority of an executive order of the President dated Aug. 23, 1917, appointing said Administrator, and of subsequent executive orders and in furtherance of said orders and of the act of Congress therein referred to and approved Aug. 10, 1917, hereby orders and directs that all prices for bituminous coal f.o.b. mines in the coal-producing districts throughout the United States fixed by the said executive order of the President, dated Aug. 21, 1917, and subsequent orders of the United States Fuel Administrator, and in effect at 7 a.m. on the 25th day of May, 1918, shall be and the same hereby are reduced as to all shipments made after 7 a.m. on the 25th day of May, 1918, by the sum of 10c. for each net ton of 2000 pounds.

This order shall in no way affect the increase contained in the executive order of the President dated Oct. 27, 1917, adding the sum of 45c. to the prices fixed for bituminous coal under the terms and provisions set forth in said last-mentioned order.

Regarding this order, the Fuel Administration has issued the following statement:

The reduction will mean an annual saving to consumers of a sum estimated by the Fuel Administration at $60,000,000. The President has directed that the railroads pay the Government price for coal. The increased cost of railroad fuel thereby occasioned is also estimated at $60,000,000 per annum. The reduction of 10c. per ton on all coal will, however, reduce the net increased cost to the railroads from $60,000,000 per annum to $45,000,000 per annum. Under the President's plan the railroads will furnish cars to all coal mines alike, without discrimination except as dictated by the prior requirements of the railroads for operating purposes and the needs of domestic consumers and of the war.

Under the present war demands the maximum output of every mine working at full time would still be insufficient to meet the country's coal needs. The principle of equal car supply has accordingly been adopted so as to make for as steady an operation as possible of all properties and for continuous employment of men, thus making for maximum output.

The introduction of the principle of even car supply will reduce the general average overhead of mine operation and thereby justifies the Administration in putting out a price reduction order. It is understood that the mine prices thus fixed will remain undisturbed until the United States Fuel Administrator has before him the cost returns for the twelve months ending Aug. 31, 1918.

The returns thus far in are being carefully studied by Fuel Administration accountants and engineers, with a view to making the utmost saving to the public that is consistent with a maximum production of coal.

The order issued tonight will have no effect on the price of anthracite, which forms the bulk of the domestic consumption fuel in the eastern part of the country.

Consumers of bituminous coal who have already entered their orders for the year's coal supply, but whose coal has not yet been delivered, will, of course, receive their supplies at the reduced price. This price applies to all coal which leaves the mines after 7 a. m., May 25, no matter how long the order for the delivery of the coal has been standing.

Coal delivered after 7 a. m., May 25, under contracts which have been entered into since Dec. 29, 1917, will be billed at the new price. Under the regulation of the Fuel Administration all such contracts call for the delivery of coal at the Government price effective at the time of delivery.

Organizing a Division of Inspection To Insure Clean Coal

To guard against the waste and serious loss resulting last winter from the shipments of dirty coal, which occupied car space and also seriously decreased industrial-plant efficiencies, the Fuel Administration has organ-

ized a division of inspection, with C. M. Means as manager. A chief inspector has been appointed in each of 21 representative districts, and where necessary assistant inspectors will be added. These inspectors will examine coal in the mines, also as dumped from mine to tipple, watch the picking tables and again inspect the coal as it is loaded in cars for shipment.

Standards will be established for insuring proper preparation according to use, so that all coal shipped must be of the quality required for its particular purpose. By condemning coal at the mine, a great improvement in the transportation situation should result in that the railroads will in effect be hauling heat units, not ash. Miners who get out dirty coal will be penalized, and a bonus system is being developed. Mines that cannot supply properly prepared coal will not be allowed to ship by rail.

Committee Studying Potomac River Power Project

A committee consisting of Brig. Gen. W. L. Marshall, chairman, Reclamation Service, Department of the Interior; Col. H. C. Newcomer, Corps of Engineers, War Department; A. L. Parsons, Bureau Yards and Docks, Navy Department, and Nelson S. Thompson, Supervising Architect's Office, Treasury Department, appointed several weeks ago, is making a study of the data at hand looking to the development of power from the Potomac River to supply electric current for various Federal and municipal uses. Two tentative plans have been prepared by Mr. Thompson. One involves building a large dam between the hills above Great Falls and conducting the water to a point near the Chain Bridge, where a fall of 180 ft. could be obtained. The estimated cost is about $40,000,000. The other plan—to build two smaller dams, one above Great Falls and another near Chain Bridge—would cost about half as much as the first plan, but would involve flooding considerable inhabited area and relocating the Chesapeake & Ohio Canal at this point.

Any plan must, however, take into consideration the water supply for the district, with its ever-increasing demands, taken from the Potomac at Great Falls. This was originally a gravity system built by and under the control of the War Department. The development of the city toward the northwest, higher ground, and the completion of a filtering system in recent years have made pumping necessary. A special report by Colonel Fiske, engineer in charge of the District water-supply system, points out the necessity for an increased water supply on account of the increased population and industrial activity. The problem therefore becomes more complicated than the usual water-power or water-supply project alone.

University of Illinois, Summer Session

The 1918 Summer Session of the University of Illinois will offer special advanced courses planned especially for instructors in mechanics in trade schools and technical schools, for chemists who wish to fit themselves to take positions involving the physical testing of materials, and for men who wish to fit themselves for positions in commercial or Government testing laboratories. Three special courses will be offered:

1. Advanced Mechanics of Materials. Advanced problems in strength of materials. A knowledge of elementary mechanics of materials is a prerequisite for this course.

2. The Properties of Engineering Materials. Lectures and assigned reading on the properties of iron, steel, other metals, wood, brick and concrete. A knowledge of elementary mechanics is a prerequisite for this course.

3. Laboratory Work in Testing Materials. Study of testing machines and strain-measuring apparatus; practice in standard methods of testing and tabulation of test results. A course in elementary mechanics of materials accompanied by work in the laboratory is a prerequisite for this course.

The extensive equipment of the materials testing laboratory of the university will be available for this work, which will be under the direct charge of H. F. Moore, research professor of engineering materials. Further information concerning the courses and expenses may be obtained from the Director of the Summer Session, University of Illinois, Urbana, Illinois.

Personals

W. V. Houck has tendered his resignation as works manager with the Sterling Engine Co. to accept a factory managership, and also an interest in the Buffalo Metal Goods Co.

Julius Alsberg has opened consulting engineering offices in the Tribune Building, 7 S. Dearborn St., Chicago. He is prepared to make investigations and reports on mechanical, industrial and chemical engineering problems, to design plants and to supervise their installation.

Robert L. Brunet, for the last five years public-service engineer of the City of Providence, R. I., and previously power engineer of the Essex Division, Public Service Corporation of New Jersey, has resigned from the former to become industrial and efficiency engineer of the Jenckes Spinning Co., Pawtucket, R. I.

Engineering Affairs

Universal Craftsmen, Council of Engineers, will hold its sixteenth annual convention at Detroit, Mich., August 5-10, with headquarters at the Statler Hotel. This is to correct error on page 642, April 30 issue.

New York State Convention N. A. S. E., will be held at Coney Island, Brooklyn, June 14-16, with headquarters and exhibits at the Shelbourne Hotel. Upwards of 60 booths have already been sold, and there is every promise of a successful meeting. Brothers McGowan, Casey, Downey and Cole are members of the hustling arrangement committee.

American Order of Steam Engineers will hold its annual meeting at Philadelphia, June 11-13. The meetings of the delegates will be held in the Parkway Building on Broad St. Because of the unsettled conditions, the display will be limited to a table exhibit. A large room has been provided for the get-together of the engineers and supplymen.

The National License Law Committee of the National Association of Stationary Engineers has had drafted and printed in pamphlet form a model state license law, as well as a set of instructions explaining and drafting a license measure. Information concerning these may be obtained by addressing the secretary of the Committee, F. W. Raven, at 417 So. Dearborn St., Chicago, Ill.

The Trustees of United Engineering Society at the regular meeting held May 23, elected the following men to the Engineering Foundation Board: Calvert Townley, of Westinghouse Electric and Manufacturing Co., New York, succeeding Gano Dunn. The following are additional members: Silas H. Woodard, Consulting Engineer, M. Am. Soc. C. E.; Dr. Joseph W. Richards, Professor of Metallurgy, Lehigh University, South Bethlehem, Penn.; Dr. David S. Jacobus, Advisory Engineer, Babcock & Wilcox Co., New York; H. Hobart Porter, of Sanderson & Porter, Consulting Engineers, New York.

The American Institute of Electrical Engineers at its annual meeting held in New York on Friday, May 17, elected the following officers for the administrative year beginning Aug 1, 1918: President, Prof. Comfort A. Adams, Harvard University, and Massachusetts Institute of Technology, Cambridge, Mass. Vice presidents, Allen H. Babcock, San Francisco, Calif.; William B. Jackson, Chicago, Ill.; Raymond S. Kelsch, Montreal, Quebec; F. B. Jewett, New York City; Harold Pender, Philadelphia, Penn.; John B. Taylor, Schenectady, N. Y. Managers, G. Faccioli, Pittsfield, Mass.; Frank D. Newbury, Pittsburgh, Penn.; Walter I. Slichter, New York City. Treasurer, George A. Hamilton, Elizabeth, N. J. These officers together with the following holdover members, will constitute the Board of Directors: E. W. Rice, Jr., Schenectady, N. Y.; H. W. Buck, New York City; C. E. Skinner, East Pittsburgh, Penn.; John B. Fisken, Spokane, Wash.; N. A. Carle, Newark, N. J.; Charles S. Ruffner, St. Louis, Mo.; Charles Robbins, East Pittsburgh, Penn.; E. H. Martindale, Cleveland, Ohio; Walter A. Hull, West Lynn, Mass.; William A. Del Mar, New York City and Wilfred Sykes, East Pittsburgh, Penn.

Miscellaneous News

Coal Production Slightly Increased—The report of the United States Geological Survey on coal production for the week ended May 11, shows the bituminous yield to have been 11,806,000 net tons, which was an increase over the preceding week of 252,000 tons, or 2.2 per cent. The anthracite production declined during the week more than 5 per cent. The shipments amounted to 38,314 carloads, as against 40,570 carloads during the previous week.

Big Turbine for New York City—The United Electric Light and Power Co., of New York City, has recently placed an order with The Westinghouse Electric and Manufacturing Co. for a 22,000-kw. turbo-generator set. The generator will be rated at 25,900 kv.-a., at 85 per cent. power factor, 8000 volts, three-phase 62½ cycles. It will be direct-connected to a Westinghouse 22,000 turbine. The order includes a 40,000-sq.ft. surface condenser and the usual auxiliaries.

Must Keep Oil Prices Steady—A communication just issued by the Oil Division of the United States Fuel Administration warns oil producers that the Government will not at this time view with approval any further advance in the price of crude oil. Competition in the form of payment of bonus is also to be restrained. By this it is not meant that varying prices should not be paid for oils of varying quality, but these differentials once established should not be further advanced.

The Penberthy Injector Co. is offering to stationary engineers' associations an artistically framed photograph showing the interior construction of their automatic injector, on which also is given a complete and concise explanation of its working. This should be of exceptional educational value and when hung in the association room it will be a permanent answer to the question, "Why does an injector work?" We suggest that the secretary of each association write at once to the Penberthy Injector Co., Detroit, Mich., for the photo, assuring them that it will be hung in the local rooms.

NEW CONSTRUCTION

N. Y., Black River—The Northern New York Utilities Co., 137 Arsenal St., Watertown, plans to build a plant on the Black River here, for the development of power. Estimated cost, $500,000. J. Brownell, Strickland Block, Carthage, Engr.

N. Y., Broadalbin—The Broadalbin Knitting Co. will soon receive bids for the erection of a 3-story, 75 x 100 ft. mill. Estimated cost, $65,000. Equipment, including electric motors, pumps, etc., will be installed. H. S. Moul, Gloversville. Arch.

N. Y., Fairport—A. S. Crocker, Engr., Mechanics Institute, Rochester, will receive bids until June 11, for the erection of a 2-story, 100 x 125 ft. factory and power plant here for the Douglas Packing Co., John St. Estimated cost, $25,000. Power equipment will be installed.

N. Y., Jamestown—The Art Metal Construction Co., Jones St. and G Ave., has had plans prepared by F. A. Shoemaker, Engr., Builders Ex., Buffalo, for remodeling and extending its boiler house.

N. Y., Olean—J. A. Coffey, Secy. Board of Armory Commission, 158 State St., Albany, will receive bids until June 12, for the installation of a complete heating system in its proposed 2-story, 52 x 110 ft. armory. Total cost, $100,000.

N. J., Gloucester City—The Pussy and Jones Co. plans to build a new electric power plant to supply power to several large shipbuilding plants.

N. J., Pompton Lakes—The City has had plans prepared by S. Firestone, Engr., Granite Bldg., Rochester, N. Y., for the erection of a hydro electric plant here. Estimated cost, $45,000. Noted May 7.

N. J., Trenton—The City plans to install 2 new pumps with generators for pumping station with 30,000,000 and 10,000,000 gal. capacity respectively. Estimated cost, $100,000. J. R. Fell, 134 North Clinton Ave., Engr.

N. J., Verona—The Board of Education will soon award the contract for the installation of a power and heating system in its proposed 4-story brick school on Laning Ave. Guilbert & Betell, 665 Broad St., Newark, Arch.

Penn., Greenville—Mercer Co. Commissioners are contemplating the erection of a brick power plant to be used for heating purposes. Plans include the installation of two 150-hp. boilers, a pump, etc.

Penn., Philadelphia—The United States Government has received bids for the erection of a 1-story, 57 x 154 ft. aircraft factory on League Island. A steam heating plant is to be installed in same. Estimated cost, $20,000. Noted May 28.

Md., Baltimore—The Maryland Creamery Co., 1726 East Pratt St., plans to build a 4-story, 50 x 90 ft., reinforced concrete, steel and brick ice manufacturing plant and cold storage building. Estimated cost, $55,000.

Va., Fieldale—The Caroline Cotton and Woolen Mill Co. is having plans prepared by F. P. Sheldon & Sons, Arch., Industrial Trust Bldg., Providence, R. I., for the erection of a weave shed and spinning mill. Motors, etc., will be installed.

Fla., Pompano—The Cypress Creek Lumber Co., Ft. Lauderdale, recently incorporated with $30,000 capital stock, plans to build a plant here. New machinery including power equipment, etc., will be installed.

Ohio, Cincinnati—The Dixie Terminal Co., 1st Natl. Bank Bldg., will purchase a battery of 200-hp. boilers for the main building to be constructed on 3rd St.

Ohio, Minster—The City will soon receive bids for the erection of a 1-story, 50 x 70 ft. power plant. Estimated cost, $50,000. V. I. Gray, 518 Nasby Bldg., Toledo, Engr.

Ind., Jeffersonville—The Quartermasters Dept., Wash., D. C., plans to appropriate $50,000 for a hospital, water pumping plant and an electric power plant here.

Ind., Maryland—The Evansville Tool Co., 9th Ave. and West Maryland St., Evansville, is having plans prepared by C. Brossman, Engr., 1618 Merchants Bank Bldg., Indianapolis, for the erection of a 1-story, 45 x 65 ft. power house. F. Lohoff, Evansville, Pres.

Wis., Depere—The Depere Manufacturing Co. has had plans prepared for the erection of an addition to its boiler works. Estimated cost, $35,000. E. S. Clark, Mgr.

Wis., Whitewater—The State Board of Normal Regents, Madison, plans to build a heating and power plant here. J. H. White, Madison, Engr.

Minn., Glen Lake—Sund & Dunham, Arch., 514 Essex Bldg., Minneapolis, will receive bids until May 31, for a built-in refrigerator and machinery for same at the Hennepin Co. tuberculosis sanitarium.

Minn., St. Paul—The State Board of Control will receive bids June 1, for the erection of a 2 story, 36 x 46 ft. power plant and laundry for the Home of Crippled Children, Phalen Park. Estimated cost, $40,000. New equipment will be installed. C. L. Pillsbury Co., 805 Metropolitan Life Bldg., Minneapolis, Engr.

N. D., Pembina—The Board of Education will receive bids until June 11, for the installation of a heating system, etc., in the grade and high school here. W. D. Gillespie, Fargo, Arch.

Mo., St. Louis—The S. S. Kresge Co., Detroit, Mich., has awarded the contract for the erection of a 3-story, 125 x 150 ft. store, to the G. A. Fuller Co., 540 Penobscot Bldg., Detroit, Mich. Estimated cost $350,000. A two pipe vacuum system will be installed by the owner.

Calif., Ontario—The Ontario Power Co. plans to build a new power house. Estimated cost, $60,000. G. D. Smith, Gen. Mgr.

Ont., Perth—The local hydro commission has been granted $35,000 for improvements to its distributing system. Work includes the installation of a transformer, erection of new lines, etc.

Sask., Gull Lake—The Canadian Pacific Railway plans to build a power house here, and will install equipment, etc. J. M. Cameron, Calgary, Alta., Gen. Mgr.

Alta., Lloydminster—W. and E. Johnson plan to build an electric lighting and power plant. Estimated cost, $60,000.

B. C., Cloverdale—The Whitlock Waterworks, Ltd., plans to transform its plant from gasoline to electric motive power. New equipment will be installed.

CONTRACTS AWARDED

R. I., Woonsocket—The Andrews Mills Co., Frankford, Philadelphia, Penn., has awarded the contract for the erection of a 2-story, 45 x 50 ft. boiler house, and a 1-story, 157 x 244 ft., weave shed, etc., to the C. I. Bigney Constr. Co., 898 Westminster St., Providence. Estimated cost, $120,000.

Conn., Thamesville (Norwich P. O.)—The Eastern Connecticut Power Co., care R. W. Peskins, Norwich, has awarded the contract for the erection of a 1-, 3- and 4-story 80 x 140 ft. power plant here, to F. T. Ley & Co., Inc., Springfield, Mass. Noted, Apr. 16.

N. Y., Gloversville—The Gloversville Knitting Co., Beaver St., has awarded the contract for the erection of a 2-story, 219 x 230 ft. knitting mill. Estimated cost, $150,000. New equipment including pumps, motors, etc., will be installed.

N. J., Jersey City—Hudson Co. let contract wiring Passaic River bridge on Lincoln Highway, to W. J. Coleman, 29 Willow Court. Estimated cost, $6000.

N. J., Newark—Mass & Walstein, Inc., Ave. R., has awarded the contract for the erection of a boiler and nitrating room addition to its plant, to H. M. Doremus & Co. Noted Apr. 9.

Penn., Philadelphia—The Bellevue Worsted Mills, Wister and Reading Rds., has awarded the contract for the erection of a 1-story, 30 x 89 ft. brick power house at 16th and Huntington Park Ave., to W. E. S. Dyer, Land Title Bldg. Estimated cost, $10,000.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for the erection of a power house and 2 transformer houses to T. Riley, Philadelphia. Estimated cost, $130,078.

Md., St. Helena—The U. S. Shipping Board, Housing Division, Wash., D. C., has awarded the contract for the erection of a power house, bakery, etc., to the Consolidated Eng. Co., Calvert Bldg., Baltimore. Estimated cost, $800,000.

Ill., Chicago—The Fleischman Co., 427 Plum St., Cincinnati, Ohio, has awarded the contract for the erection of a 4-story, 62 x 85 ft. steel and brick factory. Estimated cost, $90,000. A new boiler and refrigerators are to be installed.

Ill., Chicago—Wilder & Co., 228 West Lake St., has awarded the contract for the erection of a 5-story, 50 x 125 ft. leather factory on Hawthorne St. Additions to the present steam heat and power plants will be built. Total cost, $75,000.

Que., Montford—The Montford Orphanage has awarded the contract for the erection of a hydro electric plant here, to Arsenault & Plamondon, 70 St. James St., Montreal. Estimated cost, $15,000.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	.....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	.....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.00	$4.35	$3.90
Barley	2.15	1.50	2.40	1.75
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.65-3.00	$2.65-2.80	$2.30-2.40
2-in. lump	2.65-3.00	2.65-2.80	2.30-2.40
Steam egg	2.65-2.80	2.35-2.50	2.30-2.40
Mine-run	2.45-2.60	2.45-2.60	2.00-2.15
No. 1 nut	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.40	2.15-2.40	1.50-1.65
No. 5 washed	2.15-2.30	2.15-2.30	2.15-2.30

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T. fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

½-IN. OR PENDANT CAP			¾-IN. CAP	
Key	Keyless	Pull	Keyless	Pull
23.10c.	21.00c.	42.00c.	25.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T .P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	100
Current taps	.35	50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$20.00
No. 16 cotton twisted	24.50
No. 18 cotton parallel	21.00
No. 16 cotton parallel	28.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	38.00
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No 18 cotton Canvasite cord	25.00
No. 16 cotton Canvasite cord	32.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid. Single Braid	Solid. Double Braid	Stranded. Double Braid	Duplex
14	$11.00	$12.50	$15.00	$24.25
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	....	....	56.00	....
4	....	....	76.40	....
2	....	....	112.45	....
1	....	....	152.26	....
0	....	....	182.90	....
00	....	....	223.60	....
000	....	....	271.24	....
0000	....	....	332.40	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$13.00	$15.00	$31.09	$11.00	$20.00	$31.50	$12.00	$17.40	$36.30
10	22.15	25.25	50.05	25.40	29.00	59.00	30.30	34.30	48.80
8	31.40	34.85	69.50	35.45	35.00	72.50	42.33	46.85	67.60
6	49.40	53.30	.....	.....	61.00	120.00	64.60	74.10	.....
4	71.30	76.15	.....	.....	86.00	.....	101.75	106.55	.....
2	108.00	113.65	.....	.....	130.00	.....	151.50	163.00	.....
1	140.40	147.85	.....	.....	176.00	.....	201.00	209.50	.....
0	176.85	176.85	.....	.....	222.00	.....	276.00	285.00	.....
00	.....	239.45	.....	.....	270.00	.....	317.00	330.00	.....
000	.....	293.15	.....	.....	330.00	.....	417.00	428.00	.....
0000	.....	357.00	.....	.. ..	400.00	.....	508.00	516.00	.....

LOOM—Price per 100 ft., in coils:

Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾	150	$7.00
⅜	250	3.50	1	100	10.00
½	200	4.50	1¼	100	12.00
⅝	200	5.75	1½	100	15.00

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$66.56	$71.66	$0.1602	$0.1716	$0.059	$0.0632
¾	87.75	94.65	.2108	.2258	.0843	.0903
1	129.71	139.91	.3119	.3341	.1096	.1174
1¼	175.49	189.29	.4019	.4289	.1518	.162
1½	209.83	226.33	.5358	.5718	.1875	.2001
2	282.31	304.51	.9823	1.05	.25	.2668
2½	446.36	481.46	1.61	1.71	.3572	.3812
3	583.70	629.60	4.28	4.57	.5358	.5718
3½	729.56	784.76	9.47	10.10	.7144	.7624
4	886.17	951.57	10.93	11.67	.893	.953

From New York Warehouse—Less 5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼-in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

	Twin Conductor		Three Conductor	
Wire Gage	Cable	Connectors	Cable	Connectors
14	$65.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb.
Rubber tape, ½-lb. rolls	45c. per lb.
Wire solder, 50-lb. pools	45c. per lb.
Soldering paste, 1-lb. cans	50c. per lb.

FANS—Following are prices of fans in New York:

DIRECT CURRENT

6 in.—Universal D. C. & A. C. Diehl	$ 6.00
9 "—110 volt D. C. S&T Diehl or Sprague	11.00
9 "—110 volt D. C. Osc. Diehl or Sprague	13.75
12 "—110 volt D. C. S&T Diehl or Sprague or Eck	14.50
12 "—110 volt D. C. Osc. Diehl or Sprague or Eck	18.55
16 "—110 volt D. C. S&T Diehl or Sprague or Eck	17.25
16 "—110 volt D. C. Osc. Eck or Sprague	21.25

ALTERNATING CURRENT

9 in.—110 volt 60 cycle A. C. S&T Diehl or Sprague	$11.00
9 "—110 volt 60 cycle A. C. Osc. Diehl or Sprague	14.00
12 "—110 volt 60 cycle A. C. S&T Diehl or Sprague	14.75
12 "—110 volt 60 cycle A. C. Osc. Diehl or Sprague	18.50
16 "—110 volt 60 cycle A. C. S&T Diehl or Sprague	18.25
16 "—110 volt 60 cycle A. C. Osc. Diehl or Sprague	22.50

For 220 volt Winding—$1.00 additional

These prices are for fans 6 or more, less than this quantity add 10%.

MISCELLANEOUS

HOSE—

	Fire 50-Ft. Lengths
Underwriters' 2½-in.	75c. per ft.
Common, 2½-in.	33⅓%

	Air		
	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.60	$0.35	$0.30

Steam—Discounts from list

First grade.... 25% Second grade.... 30% Third grade.... 40%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition ..... 40% Best grade 15%
Standard 30%

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	40%
Denver	35%	30%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.60
Duck and rubber for piston packing	1.00
Flax, regular	.90
Flax, waterproofed	1.10
Compressed abestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.90
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure ..... 5% off

For low-pressure heating and return lines { 4-ply ..... 58% off; 3-ply ..... 60% off; 2-ply ..... 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5¼	6.9	7½	10½
Fiber or sponge	8	6	7.4	7½	15
Transmission	7	6	7.4	7½	13
Axle	4½	4	3.6	4	5
Gear	4½	4½	7.0	4	6
Car jornal	22 (gal.)	3½	4.5	4	6

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	11.00 to 13.00	10.00 to 12.00	16.50	12.00 to 16.50
Colored mixed	8.50 to 12.00	10.00 to 12.00	13.00	11.50 to 14.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows.

	13¼ x 13¼	13¼ x 20½
Cleveland	$52.00	$58.00
Chicago	48.00	50.00

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw per barrel	$1.55*	$1.31	$1.65	$1.32	$1.65	$1.28
5-gal. cans	1.65*	1.41	1.80	1.42	1.75	1.33

* Nominal.

WHITE AND RED LEAD in 500-lb lots sell as follows in cents per pound:

	Red				White			
	Current		1 Year Ago		Current		1 Yr. Ago	
	Dry	In Oil	Dry	In Oil	Dry and In Oil		Dry and In Oil	
25- and 50-lb. kegs	11.25	11.41	11.75	11.50	11.25		11.50	
12½-lb. keg	11.47½	11.62	12.00	11.75	11.47½		11.75	
100-lb. keg	11.02½	11.19	12.25	12.00	11.02½		12.00	
5-lb. cans	11.82½	15.25	13.75	13.50	11.82½		13.50	
1-lb. cans	13.72½	14.62½	.....	13.50	13.72½		.....	

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	30%	40%	40%*
Tinned	30%	40%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York..$6.09½ Cleveland..$5.35 Chicago..$5.50 Pittsburgh..$4.65

Coneheads, same sizes:

New York..$6.19½ Cleveland..$5.45 Chicago..$5.60 Pittsburgh..$4.75

REFRACTORIES—Following prices are f.o.b. works, Pittsburgh:

Chrome brick	net ton	$175.00
Chrome cement	net ton	75.00
Clay brick, 1st quality fireclay	per 1000	50.00– 55.00
Clay brick, 2nd quality	per 1000	35.00– 40.00
Magnesite, raw	ton	30.00– 35.00
Magnesite, calcined	ton	32.00– 35.00
Magnesite, dead burned	net ton	32.00– 35.00
Magnesite brick, 9 x 4½ x 2½ in.	net ton	110.00–125.00
Silica brick	per 1000	50.00– 60.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55; St. Louis grade, $40.
Birmingham—Fire clay, $55-60; silica, $55-60.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	125.00	70.00	118.00	74.00	110.00	65.00
Commercial	70.00	40.00	23.00	22.00	22.00	25.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$15.00	$13.00
Cleveland	15.00	12.00
Chicago	17.00	11.50

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft.	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft.	7.40	6.60	6.60	5.80
7 in. by 35 ft.	10.70	9.60	9.60	8.55
8 in. by 35 ft.	12.20	10.90	10.90	9.65
7 in. by 40 ft.	12.35	11.00	11.00	9.75
8 in. by 40 ft.	13.75	12.15	12.15	10.65
8 in. by 45 ft.	18.20	16.20	16.20	14.30
8 in. by 50 ft.	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft.	$ 9.00
12-in. butts, 6-in. tops, length 30-40 ft.	11.50
12-in. butts, 6-in. tops, length 41-50 ft.	12.50
14-in. butts, 6-in. tops, length 51-60 ft.	21.00
14-in. butts, 6-in. tops, length 61-71 ft.	23.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
¾ to 3	49%	35½%	¾ to 1½	33%	17%

LAP WELD

2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			

BUTT WELD. EXTRA STRONG PLAIN ENDS

¾ to 1½	47%	34½%	¾ to 1½	33%	18%
2 to 3	48%	35½%			

LAP WELD. EXTRA STRONG PLAIN ENDS

2	40%	28½%	2	27%	14%
2½ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	38%	42%	34.27%
3½ to 6 in. lap welded	18%	38%	21.27%
7 to 12 in. lap welded	10%	35%	21.27%

	Galvanized		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	22%	22%	19.27%
3½ to 6 in. lap welded	List	18%	13.27%
7 to 12 in. lap welded	List+20%	20%	6.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices. Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+ 5
2¼ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

Per Net Ton		Per Net Ton	
1 in.	$340	1¾ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.